FISHERY MANAGEMENT INVESTIGATIONS

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ABSTRACT

We conducted angler creel surveys on 16 randomly selected dates between June 1 and July 1, 2018 at Anderson Ranch Reservoir. Estimates of angler effort, catch rates, and frequency of bag were derived from an access-based survey at five different boat ramps. Collectively, 301 interviewed anglers completed 4,678 h of angling effort. Catch-per-unit-effort (CPUE) of kokanee *Oncorhynchus nerka* and Chinook Salmon *Oncorhynchus tshawytscha* was 0.48 and 0.02 fish/h, respectively. Smallmouth Bass *Micropterus dolomieu* CPUE was 0.6 fish/h. Anglers encountered Yellow Perch *Perca flavescens* and Rainbow Trout *Oncorhynchus mykiss* in low numbers. The mean TL (± 90% CI) of kokanee, Chinook Salmon, and Smallmouth Bass from angler creel surveys were 358 (± 2), 357 (± 11), and 358 mm (± 6), respectively.

In 2018, gill nets were utilized to sample the fishery to determine species composition, kokanee length-at-age, kokanee sex ratios, and fecundity of spawning aged kokanee. Gill net CPUE for kokanee and Chinook Salmon was 24 and 3 fish/net-night, respectively. Total length of kokanee ranged from 62 to 582 mm, with a mean length of 325 mm (± 6). Total length of Chinook Salmon ranged from 275 to 421 mm, with a mean length of 340 mm (± 7). Kokanee caught in the gill nets were 52% male, 32% female, and 16% were classified as juvenile fish, which were not identified to gender. The mean number of kokanee eggs per mature female was 1,114 eggs (± 92). Mean kokanee length at age-1 and age-2 was 248 mm (± 11) and 309 mm (± 9), respectively. Of the fish sampled, 77% of Chinook Salmon were determined to be of wild origin, while zero ventral clipped kokanee (i.e. of hatchery origin) were encountered during either the creel or gill netting efforts.

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INTRODUCTION

Kokanee salmon *Oncorhynchus nerka* exhibit multiple and often complex life history forms (Whitlock et al, 2018). Kokanee are semelparous salmon that feed and grow in lakes or reservoirs for 2.5 to 3.5 years, then spawn in tributaries or along shorelines during fall, before subsequently dying. Eggs incubate in the streambed or shoreline gravels until hatching in late winter. Alevins remain in the gravel for several more weeks before emerging and migrating to the lake or reservoir. Fry commonly migrate directly to pelagic areas (Foerster 1968), but can spend time feeding in the littoral habitats, particularly in lakes or reservoirs with pronounced littoral regions (Burgner 1991; Gemperle 1998). Juvenile and adult kokanee are most commonly associated with the pelagic zones of lakes and reservoirs, where they feed almost exclusively on zooplankton.

Management of kokanee fisheries is often complex because of the wide variation of population responses to system productivity, habitat, predation, and harvest (Paragamian 1995). These responses lead to changes in growth, fecundity, recruitment, age-at-maturity, and survival, which can also vary substantially between year classes. Many kokanee populations in the Western United States exhibit a strong density-dependent relationship between population density and mean body size (Rieman and Myers 1992; Rieman and Maolie 1995; Grover 2006). Kokanee size and growth not only influence the number and size of fish available to anglers, but also angler's perception of the quality of the fishery (Martinez and Wiltzius 1995; Rieman and Maolie 1995). The tradeoff between density and growth is an important component to kokanee management in most waters, with examples of efforts to influence density, growth, and survival being well-documented (Rieman and Myers 1992; McGurk 1999).

Kokanee are an important recreational fishery in many waters of the Western United States (Foerster 1968; Paragamian 1995; Rieman and Maolie 1995), and have become increasingly popular with Idaho anglers over the past two decades. The popularity of kokanee fishing is reflected in angling magazines, social media, kokanee tournament requests, and online forums dedicated to kokanee fishing. The Idaho Department of Fish and Game (IDFG) has observed a notable increase in angler interest in the management of kokanee fisheries across the state. The Boise River reservoirs are among the most popular kokanee fisheries in the state. Although the kokanee fisheries at Lucky Peak and Arrowrock reservoirs are dependent on hatchery stocking, the upper most fishery – Anderson Ranch Reservoir (ANR) – is mainly supported by wild kokanee recruitment (Rieman and Myers, 1991).

ANR is a 22.5 km-long Bureau of Reclamation (BOR) impoundment on the South Fork Boise River (SFBR) in Elmore County, Idaho. The dam was completed in 1950. Its spillway is at an elevation of 1,279 m above sea level. The reservoir has a maximum storage capacity of 413,100 acre-feet. Maximum depths reach approximately 91 m. The primary purpose of the dam is for irrigation, power production, and flood control. Recreational access management is controlled by the BOR and Boise National Forest. There are six boat ramps including Deer Creek, Pine, Fall Creek, Castle Creek, Curlew Creek, and Elk Creek. However, the Curlew Creek access receives the majority of angler use (Stanton et al. 2016). Anglers fishing ANR target mostly kokanee, but Rainbow Trout *Oncorhynchus mykiss*, Smallmouth Bass *Micropterus/ dolomieu*, fall run Chinook Salmon *Oncorhynchus tshawytscha*, and Yellow Perch *Perca flavescens* are also available in the reservoir. Bull Trout *Salvelinus confluentus* are present seasonally, but rarely targeted by anglers.

Idaho Department of Fish and Game primarily manages ANR as a kokanee harvest fishery with a 25-fish/d bag limit and a 75-fish possession limit (three-day bag limit). Recent forest fires and subsequent debris flows in the SFBR drainage temporarily compromised stream spawning habitat and substantially reduced kokanee recruitment to the reservoir in recent years. Because of these conditions, ANR has received annual supplementation of hatchery kokanee since 2016.

The management objectives for ANR kokanee are to provide catch rates of 1.0 f/h with mean sizes of fish ≥ 305mm.

The primary objectives of this study are to determine trends in growth, catch rates, stock contribution, and relative abundance of kokanee in ANR. Secondary objectives for this study include monitoring similar trends in the chinook fishery and catch rates of Smallmouth bass at the reservoir.

METHODS

Angler catch and harvest size

Creel surveys at boat ramps on ANR were used to collect angling data to index fisheries metrics. Data was collected by surveying anglers, similar to a portion of the access-access survey design described by Pollock et al. (1994). Surveys were conducted in June 2018, based on previous creel data that suggested June was the peak month for kokanee angling effort (Stanton et al. 2016). Kokanee, Chinook Salmon, and Smallmouth Bass were the primary focus of the evaluation; however, data on all fish species encountered was recorded.

Creel clerks were stationed at a single access site for each randomly selected creel day, to intercept anglers as they ex ited the fishery. Creel stations intercepted anglers at the Deer Creek, Pine, Fall Creek, Castle Creek, Curlew Creek, and Elk Creek boat launches surrounding ANR. Sixteen dates, with 12 weekday and four weekend/holiday days were randomly selected during June of 2018. Two time-periods were used: (1) an early (0800 - 1400 hours) and (2) a late (1400 - 2000 hours). Data collection focused on completed fishing trips. Each interview or contact was assigned a unique interview number for that day, based on the numerical order by which anglers were contacted. Number of anglers in a party, time fishing, target species, and the number of each species that were harvested or released was also recorded. Fishing method, gear type, and total length (nearest mm) and weight (g) of harvested fish were also recorded. Mean angler CPUE ($\widehat{R_2}$) was estimated using the ratio of means (ROM), where trip interviews were considered complete:

$$\widehat{R_2} = \frac{\frac{\sum_{i=1}^{n} c_i}{n}}{\frac{\sum_{i=1}^{n} e_i}{n}}$$

where $\hat{R}$ is the mean CPUE in fish/angler-hour, c_i is the number of fish caught during the trip, and e_i is the length of the trip in hours (equation $\widehat{R_2}$ from Pollock et al. 1994).

Gill Netting

Summer gill netting was implemented as a means to evaluate pre-spawn kokanee relative abundance to determine age class availability for the next year’s fishery. Sampling in July provides insight into spawner size and fecundity, relative abundance of the next years spawning age class, and provides information to determine the need for hatchery supplementation.

Gill netting was conducted at ANR July 10th, 11th, and 12th. The reservoir was stratified into three zones (Figure 1): lower, middle, and upper reservoir. Three nets were set in each zone at dusk and retrieved starting at dawn the following day. Each gill net measured 48.8 m in length and 6.0 m in depth. Gill nets contained 16 panels, each measuring 3.0 m in length. Nets consisted of eight different mesh sizes (12.7, 19.0, 25.4, 38.1, 50.8, 63.5, 76.2, 101.6 mm; stretch measure) with two panels of each mesh size randomly positioned throughout the net. Each group of gill nets were horizontally suspended so that collectively all nets covered 2 to 18 m of water depth. Sampled fish were measured for total length (mm) and weighed (g). Kokanee were processed on location to determine sex, maturity (mature vs. immature), and fecundity (eggs/female). Fecundity was estimated by counting eggs within a weighed subsample and expanding that value to the total egg weight (eggs/fish). Fecundity data was expressed as mean eggs per mature female. Otoliths were taken from a subset of 30 kokanee and length at age was determined.

In an effort to determine stock recruitment, all hatchery kokanee and Chinook Salmon stocked in ANR in 2015-17 were marked by clipping the pelvic fin and adipose fin, respectively. Kokanee were hand-clipped by Region 4 staff at the Mackay Fish Hatchery in late April of each year. Chinook Salmon were hand clipped by Nampa Research staff prior to stocking each year. All kokanee and Chinook Salmon captured in gill nets at ANR were examined for fin clips.

RESULTS

Angler catch and harvest size

A total of 301 anglers were interviewed and had a combined 4,678 h of angling effort. Anglers targeting salmonid species consisted entirely of boat anglers. Collectively, mean party size (± 90% CI) was 3.3 anglers (± 0.46) and mean trip length was 9.3 h (± 1). Species harvest composition consisted of kokanee (83%), Smallmouth Bass (11%), Rainbow Trout (3%), Chinook Salmon (2%), and Yellow Perch (1%). Kokanee and Chinook Salmon CPUE was 0.48 and 0.02 fish/hour, respectively. Mean kokanee harvested per party was 8 fish (± 2). Mean kokanee harvest/angler was 3 fish (± 1). Mean total catch (including harvest and caught and released fish) per angler was 4 fish (±1). Smallmouth Bass CPUE was 0.6 fish/h. Mean length of harvested kokanee, Chinook Salmon, and Smallmouth Bass from angler creel surveys was 358 (± 2), 357 (± 11), and 358 mm (± 6), respectively. Of the Chinook Salmon (*n* = 24) encountered during angler surveys, 92% were of wild origin, as evidenced by an intact adipose fin. No ventral fin clipped kokanee were observed during creel surveys.

Gill Netting

Gill nets captured 219 kokanee, 24 Chinook Salmon, 22 Smallmouth Bass, 19 Yellow Perch, three Rainbow Trout, two Northern Pikeminnow, one Bridgelip Sucker, and one Bull Trout. Gill net CPUE for kokanee and Chinook Salmon was 24 and 3 fish/net-night, respectively. Total length (± 90% CI) of kokanee ranged from 62 to 582 mm with a mean length of 325 mm (± 6; Figure 2). Total length of Chinook Salmon ranged from 275 to 421 mm with a mean length of 340 mm (± 7; Figure 3). Fifty-two percent of the kokanee caught in the gill nets were male and 32% were female, with the remaining classified as juvenile or unknown fish. The mean number of kokanee eggs per mature female was 1,114 (± 92). Mean kokanee length at age-1 and age-2 was 248 (± 11) and 309 mm (± 9), respectively (Figure 4). Only one age-3 kokanee was found in the sample. Of the Chinook Salmon sampled, 77% were determined to be of wild origin. No fin-clipped kokanee were encountered during gill netting efforts, suggesting 100% of catch were of wild origin.

DISCUSSION

Angler catch and harvest size

Kokanee management objectives are partially being met at ANR. Despite the mean angler catch rate for kokanee increasing from 0.3 fish/h in 2016 (Megargle et al. 2018) to 0.5 fish/h in 2018, the fishery fell short of its management objective of a 1.0 fish/h catch rate. However, the anglers interviewed expressed excitement towards high catch rates and many labelled ANR as one of the best 2018 kokanee fisheries in the western United States according to anecdotal information from multiple online forums. Such high angler excitement was likely a response to the abundance of medium- to large-sized kokanee available to anglers. The mean length of kokanee harvested in 2018 was 358 mm, which decreased from the 2016 mean length of 416 mm (Stanton et al. 2016). Although this is the third consecutive year of ANR failing to meet catch rate objectives, it is the third consecutive year of exceeding the mean length objective of 305 mm (IDFG 2019). The current management objectives may need re-evaluated to better suit the capabilities of the fishery. Current management objectives were implemented when the fishery had an overabundance of kokanee and reduced growth prior to 2012 (IDFG 2012).

Kokanee growth is density dependent, where large fish size is indicative of a low population density (Reiman and Myers 1991). High growth rates are likely a remnant response to low kokanee densities due to reduced natural recruitment and degraded spawning habitat following post fire sediment deposition in 2012 (Megargle et al. 2019). The 2013 trawl and 2014 hydroacuostic abundance estimates showed relatively low numbers of age-0 and age-1 kokanee which translated to low densities of age-3 fish in 2016 and 2017 (Megargle et al. 2018). A decrease in mean length of harvested kokanee has been observed in angler surveys since 2016.

ANR has a growing Smallmouth Bass fishery (Stanton et al. 2019). The index creel survey documented that Smallmouth Bass composed 11% percent of the species harvest composition at ANR in 2018. Smallmouth Bass catch rates and mean lengths have continually increased since 2014. Similarly, we have observed an increase in the number of bass tournaments at ANR over the past ten years (IDFG unpublished data). Despite, ANR's reputation as a kokanee fishery, anglers specifically targeting bass represented a large constituency (25%) during our survey, with kokanee anglers (72%) still making up the majority. To maintain a healthy and robust Smallmouth Bass fishery at ANR, we should tag Smallmouth Bass to develop angler use and exploitation estimates, to gain a better understanding of how anglers are utilizing these fish within the reservoir. Continued monitoring of angler effort, catch rates and harvest tendencies (e.g. frequency of bag) for all species will continue to be important for providing management guidance related to this complex fishery.

Gill Netting

Gill net CPUE for kokanee within ANR increased between 2015 and 2017 (6.4 KOK/net, 23 KOK/net, and 68 KOK/net, respectively), but decreased in 2018 to 24 KOK/net. A decrease in gill net CPUE may indicate natural population fluctuations. The fishery also experienced an increase in popularity (Table 1) potentially due to the downturn of kokanee fisheries at Lucky Peak and Arrowrock reservoirs. The increase in angling pressure may have negatively affected ANR kokanee abundance.

In 2018, the maximum observed age for Kokanee captured using the gill nets was age-3. Previous IDFG reports suggest Kokanee at ANR reach age-4 before spawning. Reports of age-4 kokanee occurred in years with relatively high abundance and reduced growth (Cassinelli and Lindley 2005), where the current evaluation occurred with relatively low abundances and high growth. Other studies have documented age-4 Kokanee in cold production limited systems with an overabundant population that exhibited slow growth (Branigan et al. 2019). Additionally, increases in length at age overlap among year classes in highly productive systems where low abundance Kokanee population's exhibit fast growth was also documented (Branigan et al. 2019). Length-at-age data from this study support that ANR is currently experiencing the later population dynamic and suggests high age-at-length overlap across year classes. ANR kokanee aging structures exhibit many false annuli, which is also synonymous with the population dynamics suggested above. Collectively, it appears the fishery at ANR has the potential to exhibit both population dynamic extremes, making management of the fishery challenging.

We also observed that 77% of the Chinook Salmon collected via gill netting were natural origin, suggesting natural recruitment is occurring within ANR. Chinook Salmon CPUE remains relatively low in the gill net catch and is not currently concerning in term of kokanee abundance. It is unlikely that Chinook Salmon are suppressing kokanee abundance. However, it will be crucial to monitor future Chinook Salmon recruitment, given the high natural origin composition. Furthermore, developing a clear understanding related to stock origin (e.g. natural vs. hatchery) and relative abundance for both kokanee and Chinook Salmon will be important to managing these fisheries.

RECOMMENDATIONS

1. Continue to evaluate stock contribution and natural recruitment to the fishery of both kokanee and Chinook Salmon.

2. Continue horizontal gill netting to monitor kokanee and Chinook Salmon relative abundances.

3. Continue monitoring growth rates of kokanee and Chinook Salmon.

4. Re-evaluate kokanee management objectives at ANR of one f/h and mean kokanee length ≥305mm.

5. Develop estimates of angler use and exploitation for Smallmouth Bass at ANR.

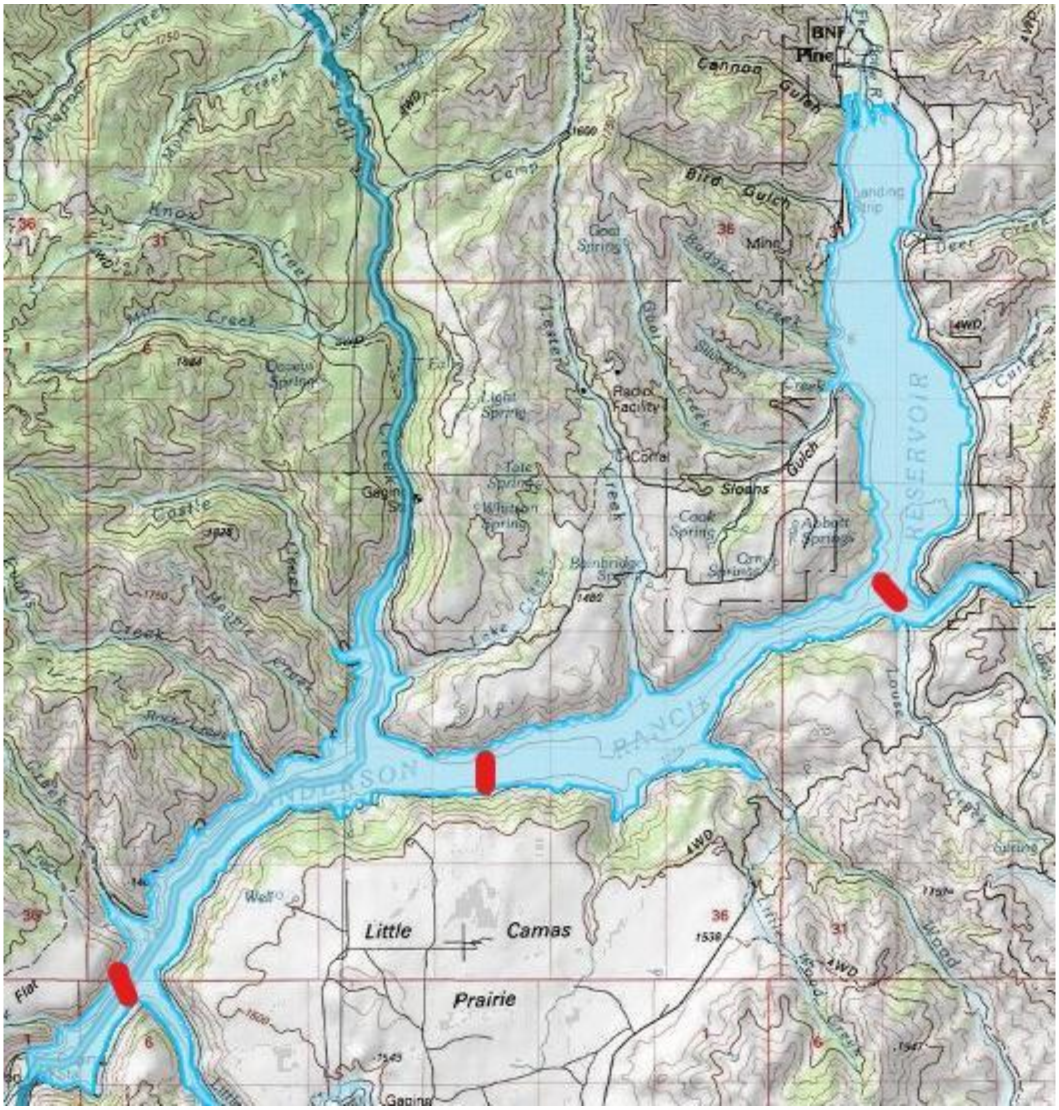

Figure 1. Gill net set locations, moving from left to right as lower, middle, and upper, on Anderson Ranch Reservoir in July 2018.

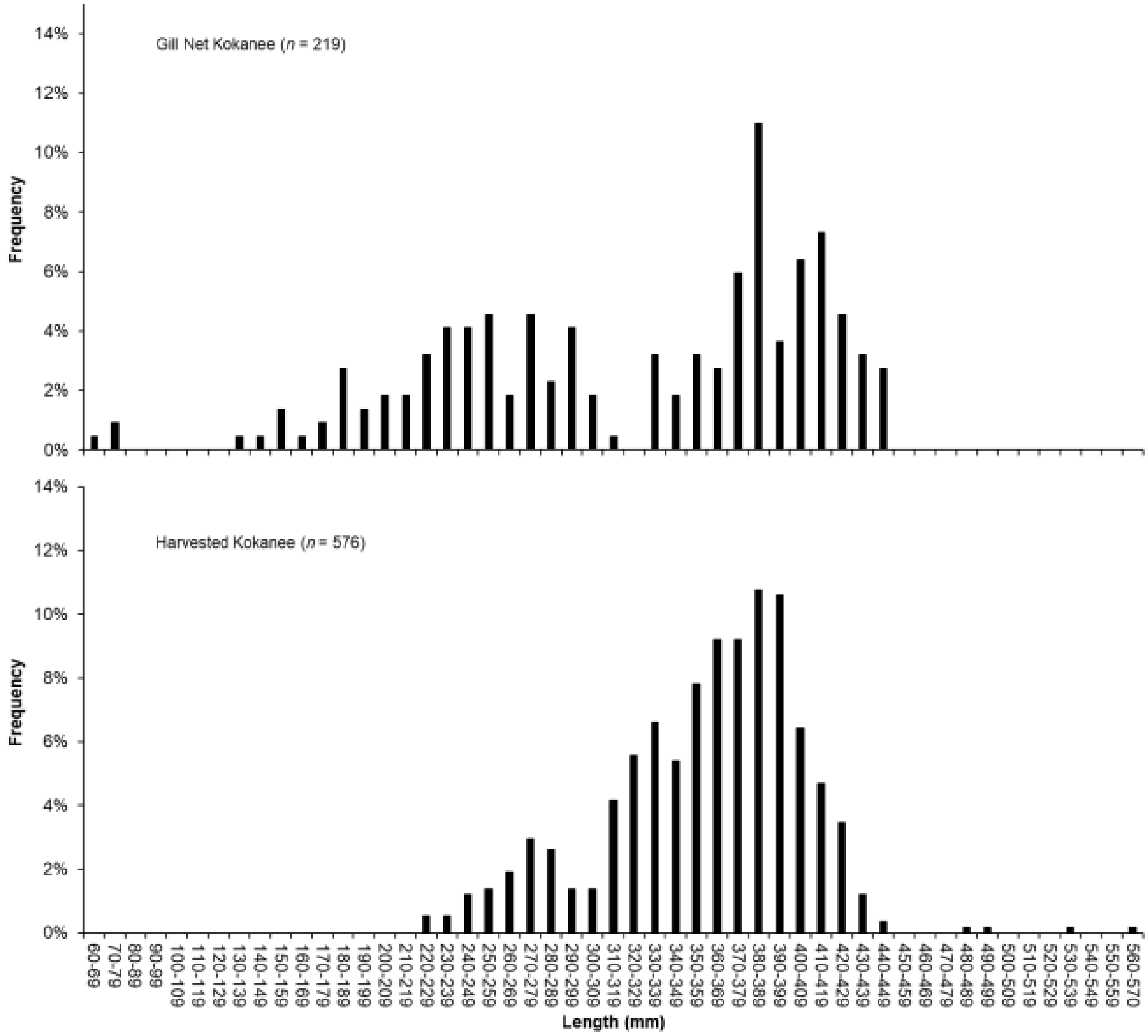

Figure 2. Kokanee length frequency generated from angler creel surveys and gill netting at Anderson Ranch Reservoir June and July 2018, respectively.

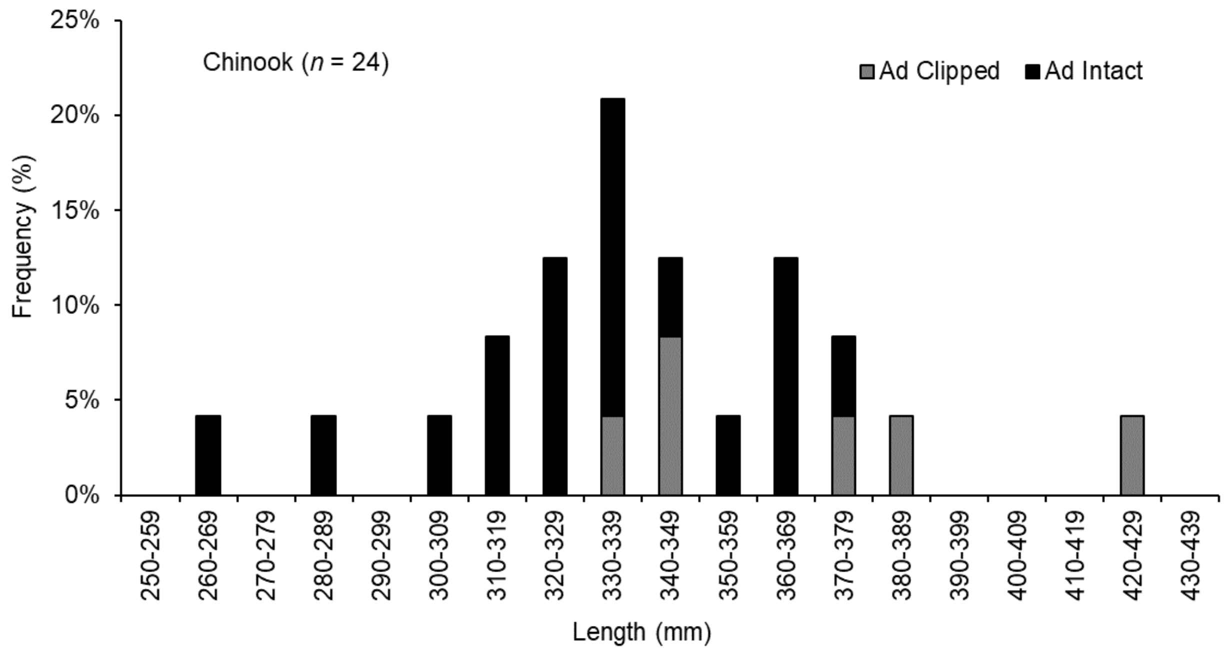

Figure 3. Length frequency of Fall Chinook Salmon with the proportion of both adipose-intact and ad-clipped generated from gill netting at Anderson Ranch Reservoir in July 2018.

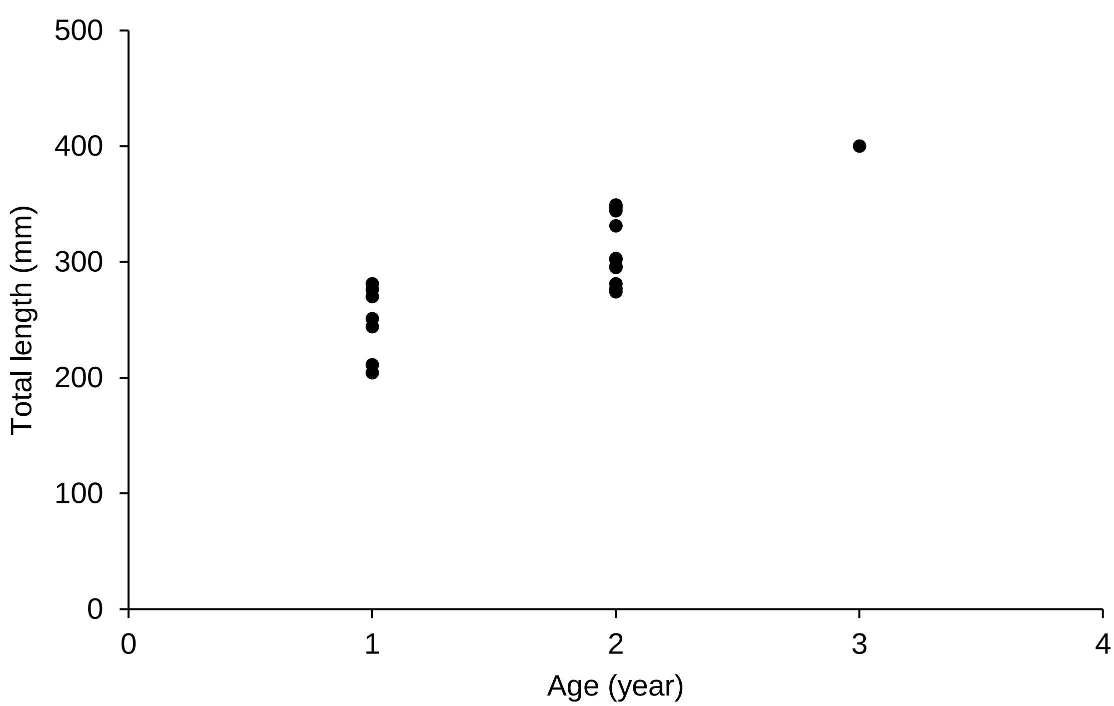

Figure 4. Kokanee length at age (n = 30) from gill net captured fish in July 2018 at Anderson Ranch Reservoir.

BRUNEAU DUNES PONDS POST TRANSLOCATION EVALUATION

ABSTRACT

Dunes Lake was chemically renovated in October of 2016 to eradicate Common Carp *Cyprinus carpio* (hereafter "carp"). The lake was restocked using Bluegill *Lepomis macrochirus* and Largemouth Bass *Micropterus salmoides* translocated from Treasureton Reservoir in Region 5, at a 9:1 Bluegill to bass stocking ratio, in 2017. We sampled Dunes Lake in May 2018 via boat electrofishing to evaluate the status of bass, Bluegill, and carp at both Dunes Lake, and the adjacent Bruneau Pond. Electrofishing CPUE (± CI 90%) for Largemouth Bass, Bluegill, and Pumpkinseed at Dunes Lake was 125 (± 28), 592 (± 75), and 54 fish/h (± 12), respectively. Mean total length (± 90% CI) of Largemouth Bass, Bluegill, and Pumpkinseed at Dunes Lake was 163 (± 4), 85 (± 1), and 94 mm (± 1), respectively. Common Carp were not encountered at Dunes Lake. Electrofishing CPUE for Largemouth Bass, Bluegill, and Common Carp at Bruneau Pond was 115 (± 28), 145 (± 16), and 5 fish/h (± 1), respectively. Mean total length of Largemouth Bass and Bluegill at Bruneau Pond was 294 (± 4) and 160 mm (± 2), respectively. Additionally, 45 Bluegill ≥ 150 mm in both Bruneau Pond and Dunes Lake were tagged and released via uniquely coded T-bar anchor tags to compare angler use and exploitation between waters. Mean length of harvested Bluegill at Bruneau Pond was 218 mm (± 7mm). At the time of reporting, only two tagged fish have been reported at Dunes Lake with lengths of 148 and 150 mm. Exploitation rates for Bluegill at Bruneau Pond and Dunes Lake were 18% (± 7; 90% CI) and 8% (± 7), respectively.

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INTRODUCTION

The Bruneau Sand Dunes are located within the Bruneau Dunes State Park approximately 25 km south of Mountain Home, Idaho. At the base of the dunes are two ponds, referred to as Bruneau Pond and the larger Dunes Lake (Figure 5), which provide warm water fisheries opportunity. These fisheries are part of several ponds developed in the early 1950s after ground water levels increased due to flood irrigation of nearby agricultural lands. However, changing irrigation practices favoring pivots resulted in a reduction of the ground water table, which dropped approximately 1.3 m. Reduced ground water levels ultimately desiccated most of the ponds, with only the two mentioned above remaining (Bruneau Pond and Dunes Lake). Anticipating the inevitable desiccation of the remaining two waterbodies, a pump was installed to bring water from the Snake River into the Bruneau Pond in 1987. Water from the Snake River has been continuously pumped into Bruneau pond both in the spring and fall since the pump installation was completed. The mean annual cost for this pumping is $8,400 (SE ± 498; IDFG unpublished data). Water is first pumped into Bruneau Pond, where it then flows through a screened head-gate on the dyke draining into Dunes Lake. Bruneau Pond is approximately 12 ha in surface area, and Dunes Lake is approximately 32 ha in surface area at current water management levels.

The fishery in both ponds is managed for Largemouth Bass *Micropterus salmoides* and Bluegill *Lepomis macrochirus.* There is currently a two-fish, 20-inch (508 mm) minimum length limit for bass on both fisheries. However, there is no size or bag limit on Bluegill. Over time, Dunes Lake has become overrun with Common Carp *Cyprinus carpio*. This has caused the Largemouth Bass and Bluegill populations to decline resulting in a loss of angling opportunity. Due to the popularity of the Bruneau Dunes State Park Campground and Idaho State Parks Departments desires to maintain good sport fishing opportunity on site, fisheries staff determined it was necessary to chemically eradicate carp from Dunes Lake in 2016. Subsequent stocking of Largemouth Bass and Bluegill occurred in May of 2017 at the suggested 9:1 Bluegill to bass ratio (Surber 1949). Dunes Lake was stocked with Bluegill and Largemouth Bass translocated from Treasureton Reservoir. Approximately, 1,400 Bluegill (mean TL = 155 mm) and 150 Largemouth Bass (mean TL = 305 mm) were released on May 21, 2017.

Bruneau Pond and Dunes Lake have historically been a trophy Bluegill and Largemouth Bass fisheries in past decades. However, it is unclear if current trophy bass regulations have equated to trophy-sized bass. Therefore, the objectives of this study were multi-faceted and were to: (1) determine if Common Carp persisted in Dunes Lake; (2) determine if donor fish successfully spawned in 2017; (3) determine if Largemouth Bass are attaining 20-inch trophy lengths in Bruneau Pond; and (4) estimate angler use and exploitation of Bluegill in both fisheries.

METHODS

Sampling at both Bruneau Pond and Dunes Lake was completed via nighttime boat electrofishing; using a Midwest Lake Electrofishing System (MLES) Infinity unit set at 24% duty cycle and approximately 2,200-2,800 W of pulsed DC power. Current was generated using a 7,000-W Honda generator. The entire perimeter of both waterbodies were sampled in three timed, power on, transects. Catch results were reported as relative abundance and expressed as mean catch per unit effort (CPUE; ± 90% CI). Sampling was conducted on May 19, 2018. All fish sampled were measured for total length (TL; mm), and a subset of 50 bass and Bluegill were weighed (g). Captured Common Carp were disposed at the Hagerman Wildlife Management Area, via a burial pit. Additionally, a mechanical carp suppression was completed in October, 2018 via boat electrofishing

A total of 45 Bluegill were tagged with 70-mm fluorescent orange T-bar anchor tags and released in each fishery to estimate angler use and exploitation. These fish were measured to the nearest mm, and tagged just under the dorsal fin. A total of 10% of tagged fish were double-tagged to estimate tag loss. Fish were held in a 200-gallon, oxygenated recovery tank for one hour to estimate short-term tagging mortality.

Angler catch and exploitation data was developed using the anchor tags reported by anglers according to the methods described in Meyer and Schill (2014). In short, anglers could report tags using the IDFG "Tag-You're-It" phone system or website (set up specifically for this program), as well as at regional IDFG offices or by mail. Anchor tags were labeled with "IDFG" and a tag reporting phone number on one side, with a unique tag number on the reverse side.

Total angler returns (*c*) were calculated based on the number of tagged Bluegill reported as caught within one year of stocking, divided by the number of tagged Bluegill released. This included all Bluegill caught, including those released back into the fishery. Angler returns were evaluated within the first year post-release. Total angler returns were adjusted (*c*'), to estimate the total proportion of bluegills caught by anglers for each fishery, by incorporating the angler tag reporting rate (λ); (Parsons and Reed [1998] 63%), tag loss (*Tagl*), and tagging mortality *(Tagm*); (Meyer and Schill [2014] 0.8%). Estimates were calculated for each individual fishery using the formula:

$$\mathrm{c}' = \frac{c}{\lambda(1 - Tagl)(1 - Tagm)}$$

Finally, days-at-large of Bluegill that were eventually caught post-stocking was calculated by subtracting the stocking date from the date that each angler reporting catching their tagged fish.

RESULTS

A total of 193 Largemouth Bass, 915 Bluegill, and 83 Pumpkinseed *Lepomis gibbosus* were collected at Dunes Lake. Electrofishing CPUE (± CI 90%) for Largemouth Bass, Bluegill, and Pumpkinseed at Dunes Lake was 125 (± 28), 592 (± 75), and 54 fish/h (± 12), respectively. Mean total lengths for Largemouth Bass, Bluegill, and Pumpkinseed at Dunes Lake was 163 (± 4), 85 (± 1), and 94 mm (± 1), respectively. Bluegill lengths at Dunes Lake ranged from 40 to 234, with a mean total length of 85 mm (± 6; Figure 6). Largemouth Bass lengths at Dunes Lake ranged from 88 to 429 mm, with a mean total length of 163 mm (± 4; Figure 7). No Common Carp were encountered at Dunes Lake.

Electrofishing CPUE for Largemouth Bass, Bluegill, and Common Carp at Bruneau Pond was 115 (± 28), 145 (± 16), and 5 fish/h (± 1), respectively. Mean total length for Largemouth Bass and Bluegill at Bruneau Pond was 294 (± 4) and 160 mm (± 2), respectively. The total length of Largemouth Bass at Bruneau Pond ranged from 170 to 405 mm. Spring sampling yielded six carp with total lengths ranging from 420 to 519 mm. Additional fall carp suppression yielded 19 fish with total lengths ranging from 470 to 770 mm.

A total of five tagged Bluegill were returned at Bruneau Pond, with a mean length of 218 mm (± 7). Two tagged Bluegill were reported at Dunes Lake, with lengths of 148 and 150 mm. Exploitation rates for Bruneau Pond and Dunes Lake were 18% (± 7) and 8% (± 7) (90%CI), respectively. All tagged fish reported were harvested. Collectively, 66% of the harvested Bluegill occurred between May and the end of June, with only one tag reported after June. Mean days-at-large for tagged Bluegill in Bruneau Pond was 30 (± 14). Days-at-large for the two tagged Bluegill returned at Dunes Lake were five , and 19.

DISCUSSION

Both Largemouth Bass and Bluegill translocated and released at Dunes Lake in 2017 appear to have successfully spawned. However, the current ratio of Bluegill to bass is 5:1, which is half of the commonly accepted reintroduction ratio of 10:1 (Wright and Kraft 2012). Bass generally do not spawn until age-2, and can experience delayed reproductive maturity in northern latitudes (Dillard and Novinger 1975); which may explain relatively low bass CPUE one year post reintroduction at Dunes Lake. Although, reduced Bluegill:Largemouth Bass ratios have been shown to increase the growth rate of Bluegill (Dauwalter and Jackson 2005), such a population dynamic relies on the presence of adult bass large enough to consume abundant juvenile Bluegill; which is not currently the case at Dunes Lake. Additionally, Largemouth Bass experience reduced rates of predation on Bluegills in systems overly abundant with submerged vegetation, which often leads to an overabundant Bluegill population (Regier 1963). Dunes Lake is currently experiencing an overabundance of submerged vegetation after eradicating Common Carp in 2016 (IDFG 2016). In their northern range, overabundance of Bluegill can prevent recruitment of Largemouth Bass (Wright and Kraft 2012) through competition. The factors listed above (e.g. slow bass maturity, excessive submerged vegetation, reduced Bluegill predation) reiterates the importance of monitoring post renovation species composition in an effort to maintain balanced Largemouth Bass and Bluegill populations. Continued monitoring will be needed to identify if a balanced population is achieved from these translocation efforts.

We documented Pumpkinseed in Dunes Lake at a higher CPUE than any previous survey. Pumpkinseed were first documented in Dunes Lake in 2001, but have yet to be documented in Bruneau Pond which is the feeder system to Dunes Lake. Donor populations of Bluegill were collected at Treasureton Reservoir, which has not documented Pumpkinseed. Therefore, it is unclear why Pumpkinseed CPUE has increased since the rotenone treatment. It is possible that not all of the Pumpkinseed were removed during the rotenone treatment and because of reduced competition from other species, they may have flourished in the interim period prior to reintroductions occurring. It is also possible that anglers may have tried to resurrect the panfish fishery by introducing fish from a nearby source (e.g. CJ Strike Reservoir). Continued monitoring of these fisheries will be important to identify changes in species composition through time.

Current regulations at Bruneau Pond restrict the harvest of Largemouth Bass under 20” (508 mm). Our sampling efforts in 2018 did not yield a bass that met the criteria for harvest. Given the current Largemouth Bass length frequency distribution at Bruneau Pond (Figure 7), we could achieve similar size structure if a 16” (406 mm) bass limit was implemented. Additionally, robust minimum length regulations (≥ 406mm) for Largemouth Bass can shift predation towards larger Bluegill, cropping off the availability of the larger age classes of fish (Spotte 2007). Prior to recommending any changes to Largemouth Bass size restrictions, growth data should be collected on both Bluegill and bass to evaluate the efficacy of the 20” (508 mm) minimum Largemouth Bass limit at Bruneau Pond. These data would allow us to determine if removing smaller bass from the pond via electrofishing or harvest would increase growth rates and bass size structure.

Based on tag returns, exploitation was higher at Bruneau Pond than at Dunes Lake. Bruneau Pond experiences 5 times the angling effort that Dunes Lake does during May and June, based on 2014 creel data (Megargle et al. 2020). However, according to State Park staff observations, Dunes Lake receives the majority of angling effort during the summer months. The low exploitation rate (8%) and short time frame since the rotenone treatment may suggest there is a lack of “harvestable” sized fish available in the fishery, which is reflected in our fish sampling data. It may be necessary to provide additional temporary angling opportunities while allowing the Bluegill and Largemouth Bass populations to grow to a harvestable size, such as triploid hatchery Rainbow Trout. Channel Catfish might provide another opportunity to temporarily bolster angling in Dunes Lake, however Bluegill populations in small impoundments generally struggle when catfish are present (Spotte 2007).

RECOMMENDATIONS

1. Monitor Largemouth Bass and Bluegill size structure, species composition, growth, and relative abundance via electrofishing on 5-year intervals.

2. Collect Largemouth Bass and Bluegill growth data to evaluate potential impacts of reducing the current 20” bass length restriction.

3. Create additional short-term angling opportunity at Dunes Lake with a put-and-take trout fishery during spring and potentially fall months.

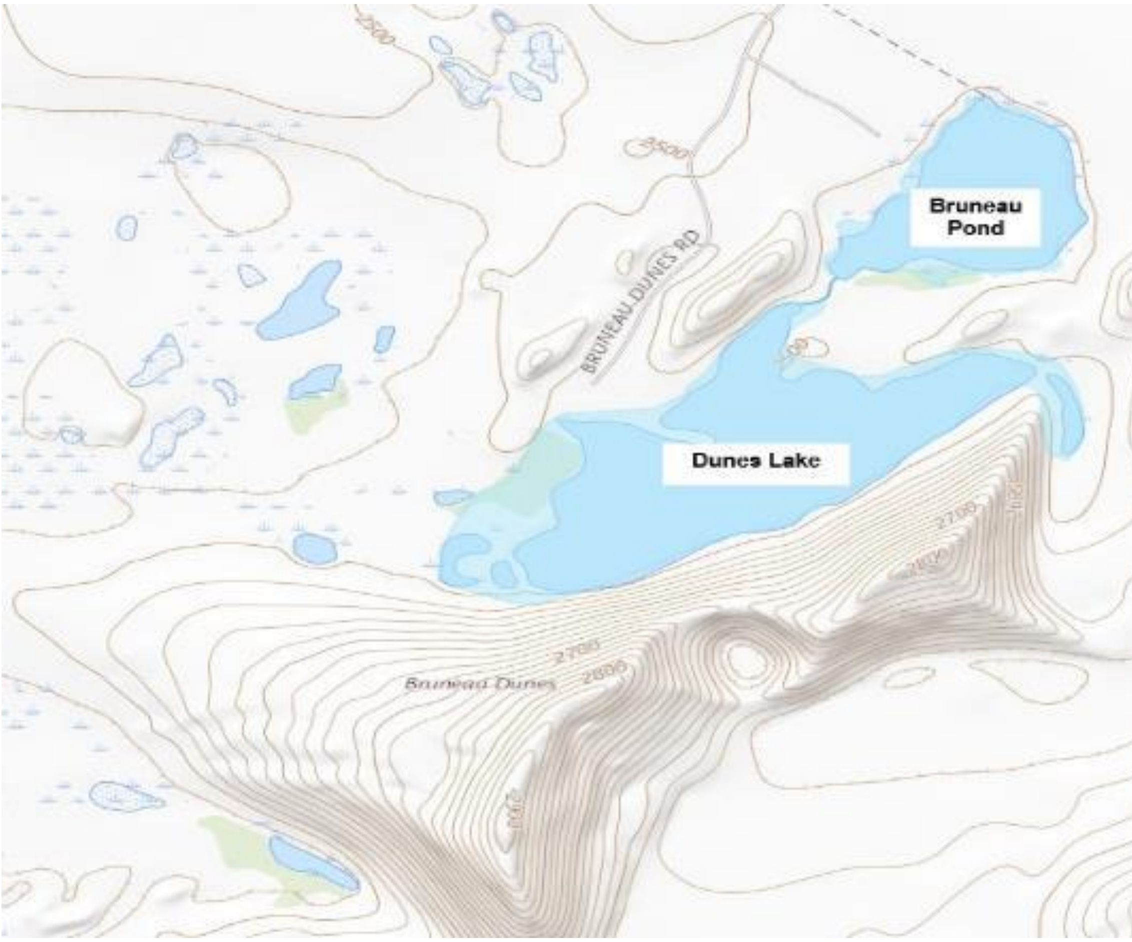

Figure 5. Topographic site map of Dunes Lake and Bruneau Pond, located at the Bruneau Dunes Idaho State Park.

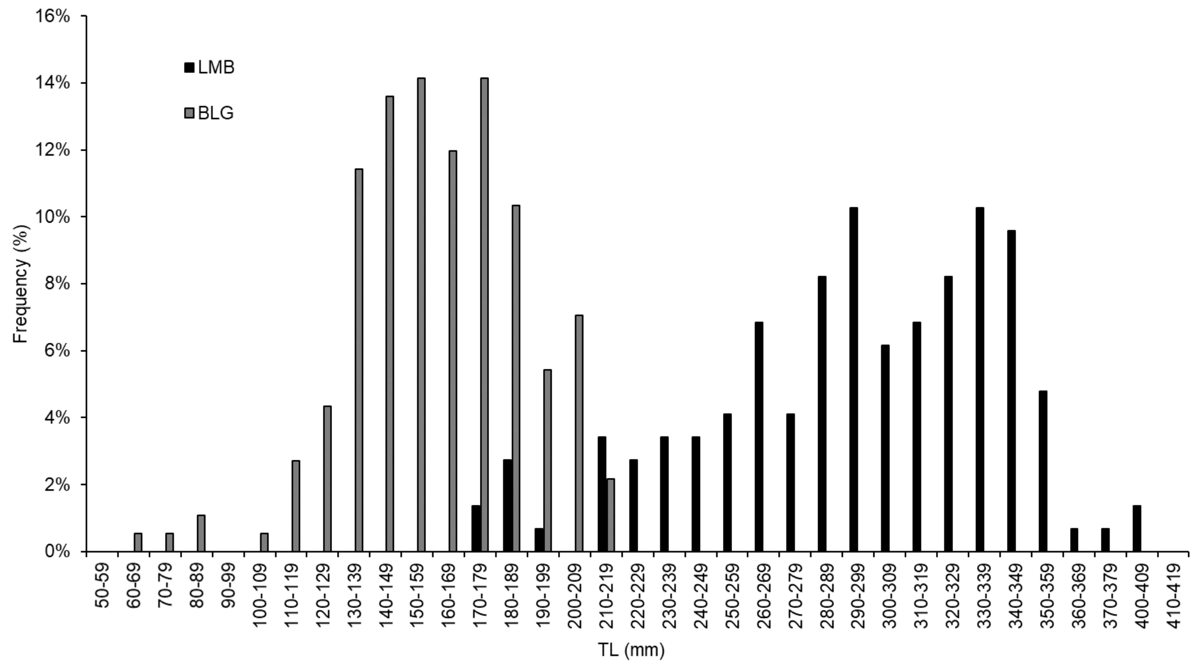

Figure 6. Length frequency histogram of electrofished Largemouth Bass (n=146) and Bluegill (n=184) at Bruneau Dunes Pond in May 2018.

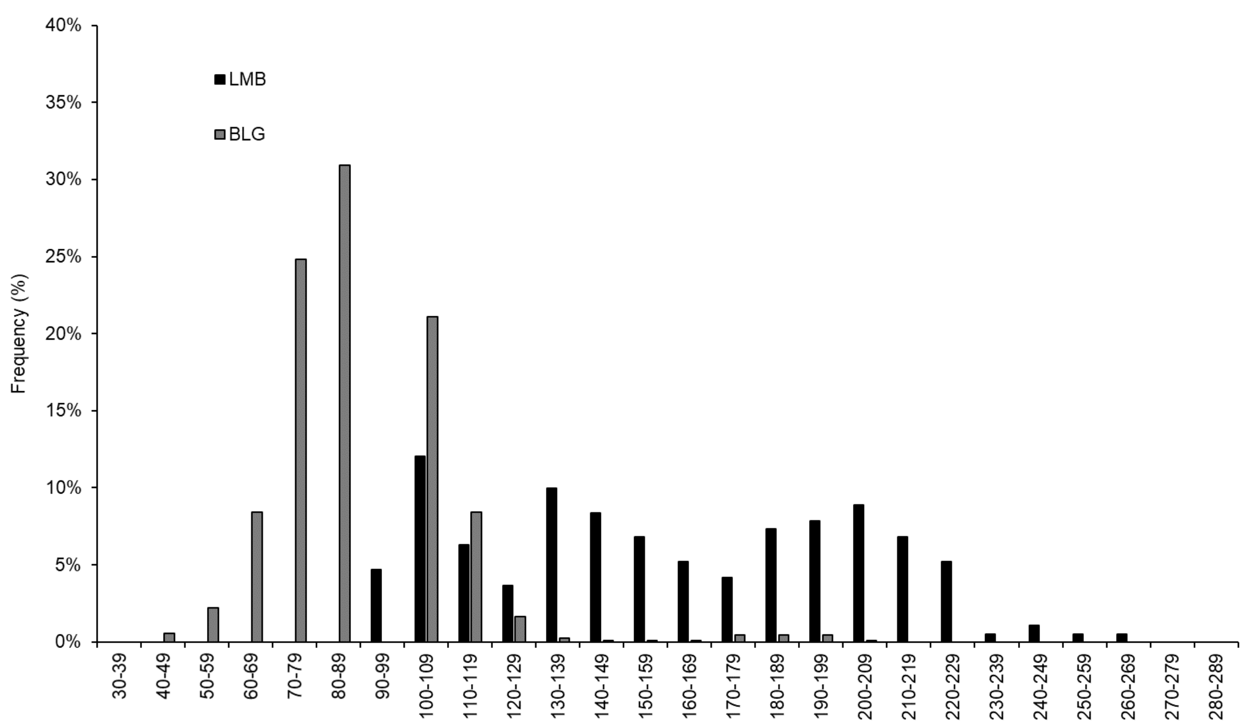

Figure 7. Length frequency histogram of electrofished Largemouth Bass (n=191) and Bluegill (n=915) at Dunes Lake in May 2018.

HAGERMAN WEST POND POST TRANSLOCATION EVALUATION

ABSTRACT

Hagerman West Pond was chemically treated using rotenone in 2014 to remove Common Carp *Cyprinus carpio*. Largemouth Bass *Micropterus salmoides* and Bluegill *Lepomis macrochirus* were reintroduced in 2016. We revisited the pond in 2018 to determine if reintroduced Largemouth Bass and Bluegill successfully reproduced, and to verify the efficacy of eradicating common carp in 2014. A total of 90 Largemouth Bass and 59 Bluegill were collected at West Pond. Electrofishing CPUE (± CI 90%) for Largemouth Bass and Bluegill at West Pond was 43 (± 13) and 28 fish/h (± 7), respectively. Mean total length (± 90% CI) of Largemouth Bass was 200 mm (± 4; Figure 8). Mean total length of Bluegill was 144 mm (± 3; Figure 11). Largemouth Bass and Bluegill lengths ranged from 110 to 349 mm and 60 to 209 mm, respectively. Common Carp were present in both spring and fall electrofishing efforts, indicating the rotenone treatment was not successful.

INTRODUCTION

The Hagerman Wildlife Management Area (HWMA) is located approximately four km south of Hagerman, Idaho in Gooding County. It is located near several Magic Valley communities and provides fishing opportunities to thousands of anglers each year. The HWMA is primarily managed for waterfowl; however, anglers are the principal recreational users (Skyler Farnsworth - IDFG Habitat Biologist, personal communication). In the 1940s, a series of ponds were developed with dikes and dams to provide overwinter and rearing habitat for waterfowl. An ancillary benefit of pond construction is the sport fish opportunity on site. Collectively, there are 16 ponds located on the HWMA including: Oster Lakes 1-6, Anderson Ponds 1-4, Big and Little Bass Ponds, the Goose Pond, Riley Creek Pond, the Hatchery Settling Pond, and West Pond. The majority of ponds are filled and maintained by Riley Creek and Tucker Springs water; however, the West Pond is filled with Buckeye Canal return water and two unnamed springs. The outflow of West Pond consists of an unscreened drop culvert that spans underground beneath Highway 30 and flows into Anderson #3. West Pond is a 8.5 ha pond with a mean depth of approximately 2-3 m. (Figure 8) Overhanging vegetation and bull rushes are present around the majority of the pond, with an abundance of submerged vegetation. West Pond is closed to all fishing from November 1 to June 31 for waterfowl and has a non-motorized watercraft restriction.

Historically, HWMA provided both put-and-take trout, Largemouth Bass *Micropterus salmoides*, and Bluegill *Lepomis macrochirus* fishing opportunities in the Magic Valley Region. Generally, the eastside ponds provided trout (Oster 1-5, Anderson 1, and the Settling Pond), while the west side ponds (Riley Creek Pond, Anderson 2-4, Goose Pond, Bass Pond 1 and 2, and West Pond) provided Largemouth Bass and Bluegill fishing opportunities. Common Carp *Cyprinus carpio* became established in the mid 1990s in all but three ponds: Bass ponds 1-2, and the Goose Pond (Stanton et al. 2015). Common Carp have negatively impacted Largemouth Bass and Bluegill populations, and subsequent declines in angling effort were documented (Drenner et al. 1997). Presently, the majority of angling effort occurs at Riley Creek Pond (Stanton and Stanton 2011), which in recent decades has been managed as a put-and-take trout fishery with annual stockings of nearly 18,000 catchable trout. Because Riley Creek Pond receives the majority of stocking and angling effort on the WMA, angler success is immediately reliant on stocking events and is short-lived (Stanton et al. 2015). Additionally, access to all the western ponds except Riley Creek Pond and West Pond has decreased through time (e.g. gated roads, overgrown dykes and increased aquatic vegetation).

Put-and-take trout opportunity has maintained HWMA’s popularity among anglers, but the warm water fisheries are not meeting angler demand (Stanton and Stanton 2014). IDFG personnel began the process to recover the Largemouth Bass and Bluegill fisheries at HWMA in 2011. A plan was developed to implement a series of chemical treatments using rotenone in the Anderson Ponds (Stanton et al. 2012) and West Pond (Stanton and Stanton 2014). Anderson Ponds 1 and 2 were treated in 2011, West Pond in 2014 and Anderson Ponds 3-4 and Riley Creek Pond in 2015. Largemouth Bass (n = 100) and Bluegill (n = 1,400) were translocated from Treasureton Reservoir in 2016, and released into West Pond in an effort to re-establish the fishery.

The objectives of this study were to: (1) determine the efficacy of eradicating Common Carp, (2) determine if efforts to re-establish West Pond with Largemouth Bass and Bluegill following rotenone treatment resulted in successful recruitment of progeny, and (3) evaluate angler use and exploitation of Bluegill and Largemouth Bass, in West Pond on the HWMA.

METHODS

Sampling at West Pond was completed via nighttime boat electrofishing using a Midwest Lake Electrofishing System (MLES) Infinity unit set at 24%, duty cycle and approximately 2,200-2,800 watts of pulsed DC power. A 7000-watt Honda generator was used to generate power. The entire perimeter was sampled in three timed, power on, transects. Catch results were reported as relative abundance and expressed as mean catch per unit effort (fish/h; ± 90% CI), and species composition (percent). Sampling was conducted on May 30, 2018. All fish sampled were measured for total length (TL, mm), and a subset of 50 Largemouth Bass and Bluegill were weighed (g). Common Carp that were captured were removed from the pond and disposed of at Hagerman WMA, via a burial pit. Additionally, a mechanical carp suppression was completed in October, 2018 via boat electrofishing.

An additional 45 Bluegill and 45 Largemouth Bass were tagged with 70-mm fluorescent orange T-bar anchor tags and released into the fishery. These fish were measured to the nearest mm, and tagged just under the dorsal fin. A total of 10% of tagged fish were double-tagged to estimate tag loss. Fish were held in a 200 gallon oxygenated recovery tank for one hour to evaluate short term tagging mortality.

Angler use and exploitation data was based on the anchor tags that were reported by anglers. For a detailed description of the angler tag reporting system used, see Meyer and Schill (2014). In short, anglers could report tags using the IDFG "Tag-You're-It" phone system or website (set up specifically for this program), as well as at regional IDFG offices or by mail. Anchor tags were labeled with "IDFG" and a tag reporting phone number on one side, with a unique tag number on the reverse side.

Total angler returns (*c*) were calculated as the number of tagged fish reported as caught within one year of stocking, divided by the number of tagged fish released. This included all fish caught, including those released back into the fishery. Angler returns were evaluated within the first year post-release. Total angler returns were adjusted (*c*'), to estimate the total proportion of bluegills caught by anglers for each fishery, by incorporating the angler tag reporting rate (λ); tag loss (*Tagl*), and tagging mortality (Tagm); (Meyer and Schill [2014] 0.8%). A reporting rate of 0.63 (Parsons and Reed 1998) was used for estimating Bluegill exploitation, and a reporting rate of 0.38 (Meyer and Schill 2014) was used for estimating Largemouth Bass exploitation. Estimates were calculated for each individual fishery using the formula:

$$c' = \frac{c}{\lambda(1 - Tagl)(1 - Tagm)}$$

Finally, days-at-large of Bluegill that were eventually caught post-stocking was calculated by subtracting the stocking date from the date that each angler reporting catching their tagged fish.

RESULTS

A total of 90 Largemouth Bass and 59 Bluegill were collected at West Pond. Electrofishing CPUE (90% CI) for Largemouth Bass and Bluegill at West Pond was 43 (± 13) and 28 fish/h (± 7), respectively. Mean total length (90% CI) of Largemouth Bass was 200 mm (± 4; Figure 10). Mean total length of Bluegill was 144 mm (± 3; Figure 11). Largemouth Bass and Bluegill lengths ranged from 110 to 349 mm and 60 to 209 mm, respectively.

Collectively, four tagged Largemouth and one tagged Bluegill were returned. Mean total length of harvested Largemouth Bass at West Pond was 245 mm (± 33), with lengths ranging from 225 to 349 mm. One tagged Bluegill was reported at West Pond with a length of 170 mm. Estimated angler exploitation and use rates (90% CI) for Largemouth Bass at West Pond were 7% (± 8) and 26% (± 16), respectively. Mean days-at-large for Largemouth Bass was 61 (± 13). The one angler reported Bluegill was at large for 76 days.

Common Carp were present in both spring and fall electrofishing efforts. A total of six carp were collected in spring. Fall efforts collected 259 carp with a mean length of 668 mm (± 8; Figure 9) and a CPUE (CI 90%) of 74 fish/h (± 17) of electrofishing. Yellow Bullhead (n = 7) and Perch (n = 2) were also encountered at low frequency during this sampling event.

DISCUSSION

Common Carp eradication via rotenone at West Pond was unsuccessful based on the post treatment presence of the species. Prior to rotenone treatment in 2014, electrofishing efforts at West Pond removed 164 Common Carp with a mean total length of 727 mm (± 20), for a CPUE of 99 fish/h (± 10; IDFG unpublished data). Current size structure of Common Carp in West Pond is smaller than pre rotenone treatment, which may reduce the immobilization efficiency when sampling (Dolan and Miranda 2003) indicating abundance may actually be higher than reported. Reductions in size class and increases in total fish caught from 2013 to 2018 may be a result of higher densities of smaller, younger fish. The treatment was not effective at suppressing the population (long term) and even if Common Carp numbers decreased significantly by the treatment originally, the species has rebounded back to near pre-treatment relative abundance.

This study did not identify the population source that recolonized Common Carp in the West Pond post application, or the causation of a failed rotenone treatment. We speculate a multitude of variables may have resulted in an incomplete eradication of Common Carp. First, two subsurface springs located on the south side of the pond and the presence of dense bull rushes surrounding the perimeter of the pond may have reduced the effectiveness of the treatment. Both the springs and bull rush habitats did not receive the suggested "dough ball" application treatment suggested by Finlayson et al. (2018), which may have provided short-term refugia for Common Carp. A second possible source was from the Buckeye Canal, which fills a private pond before flowing into West Pond and was not treated with rotenone. Road construction in 2016 resulted in the installation of an unscreened culvert, potentially providing increased passage between the private pond and West Pond, possibly reintroducing Common Carp back into the pond. The third possibility for the failed treatment may have been because Riley Creek Pond did not receive direct rotenone treatment until one year after the West Pond project. Applicators relied on effluent rotenone product from West Pond and simultaneous treatments at Anderson Ponds 3 and 4 to treat Riley Creek Pond. Because Riley Creek Pond is the largest pond in the HWMA system and receives most of its water from Riley Creek, a separate untreated water source, it is likely that the active ingredient (rotenone) was diluted to non-lethal dose allowing for carp survival in Riley Creek Pond. Considering all the habitat variables, total eradication of carp in West Pond may be unlikely via mechanical and/or chemical efforts.

Translocation efforts of Largemouth Bass in West Pond were a success based on the presence of two age classes, which represents naturally-recruited cohorts from 2016 and 2017. However, catch data suggests size structure has decreased from pre-rotenone treatment to 2018 (Figure 9); which is to be expected with the majority of catch consisting of either age-1 and age-2 fish. It is uncertain if angler harvest of short bass is negatively affecting size structure at this time. Largemouth Bass electrofishing CPUE did not significantly change from 48 (± 31) in 2014, to 43 fish/h (± 13) in 2018. Future monitoring of Largemouth Bass growth and relative abundance is needed to ensure a healthy population of Largemouth Bass at West Pond.

The 2018 ratio of Bluegill to Largemouth Bass in West Pond is 2:3, which is inverse to the preferred species compositions of 10:1 suggested by Wright and Kraft (2012). Reduced Bluegill:bass ratios have been shown to increase the growth rate of Bluegill (Dauwalter and Jackson 2005). Although size structure and growth rates can be relatively high, inverse Bluegill:bass ratios favoring more bass than Bluegill can limit the availability of Bluegill in a fishery (Wright and Kraft 2012). Simultaneous exploitation studies of Largemouth Bass and Bluegill at West Pond indicated more Largemouth Bass were harvested than Bluegill. Future monitoring is needed to evaluate the balance of Bluegill and Largemouth Bass ratios, and to determine growth rates, angler use, and exploitation for these species.

RECOMMENDATIONS

1. Continue to monitor the Largemouth Bass and Bluegill size structure, species composition, growth, and relative abundance via electrofishing on 5-year intervals.

2. Tag additional Largemouth Bass and Bluegill within West Pond to monitor angler use and exploitation for this fishery.

Figure 8. Hagerman West Pond topographic site map used to illustrate its location relative to the other ponds on the Hagerman Wildlife Management Area.

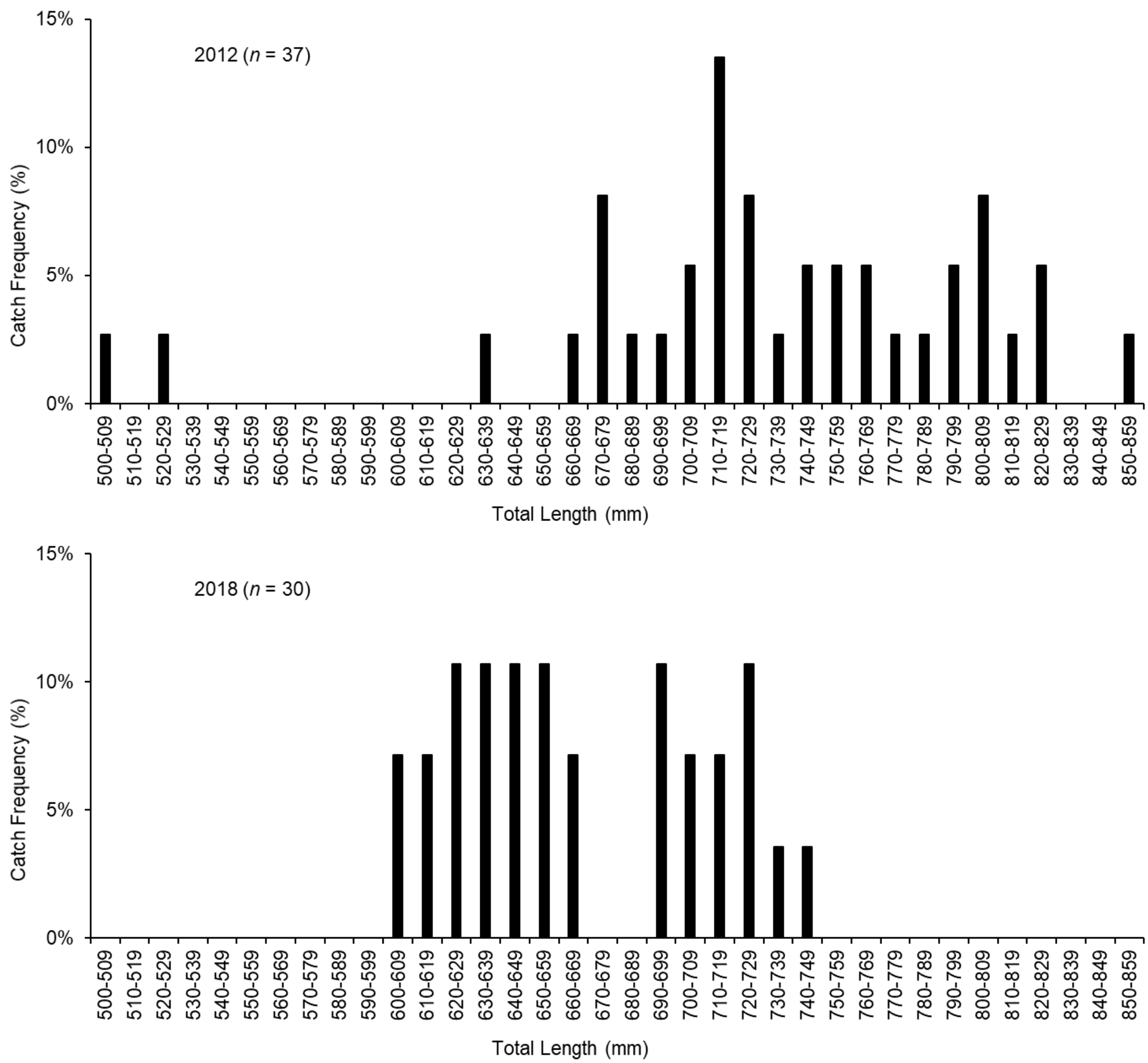

Figure 9. Length-frequency histogram of Common Carp in West Pond via electrofishing pre (2012) and post rotenone treatment (2018).

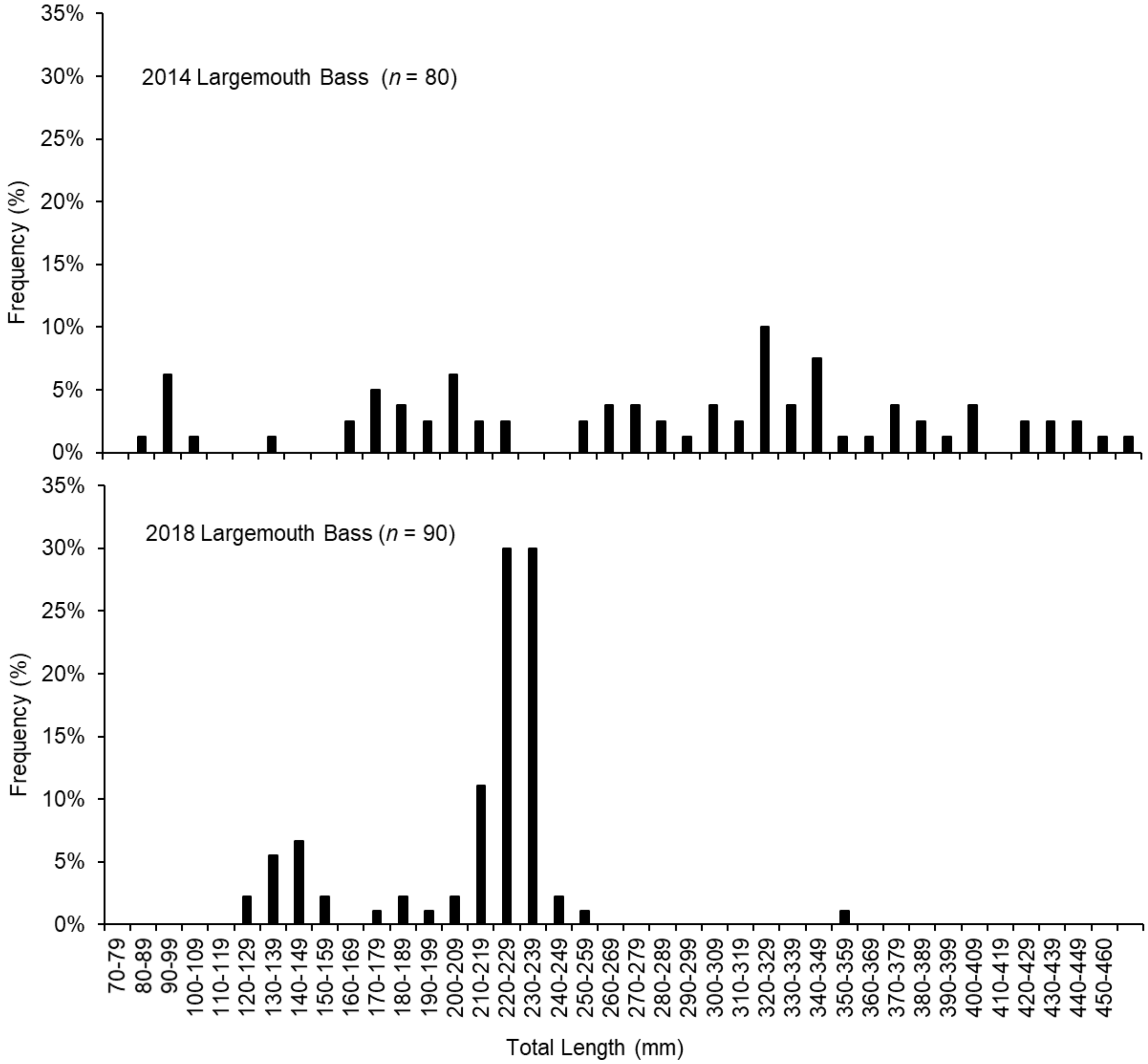

Figure 10. Length-frequency histogram of Largemouth Bass in West Pond captured using electrofishing gear in 2014 (pre-rotenone) and 2018 (post rotenone translocation). The rotenone treatment was followed by the translocation efforts in 2016.

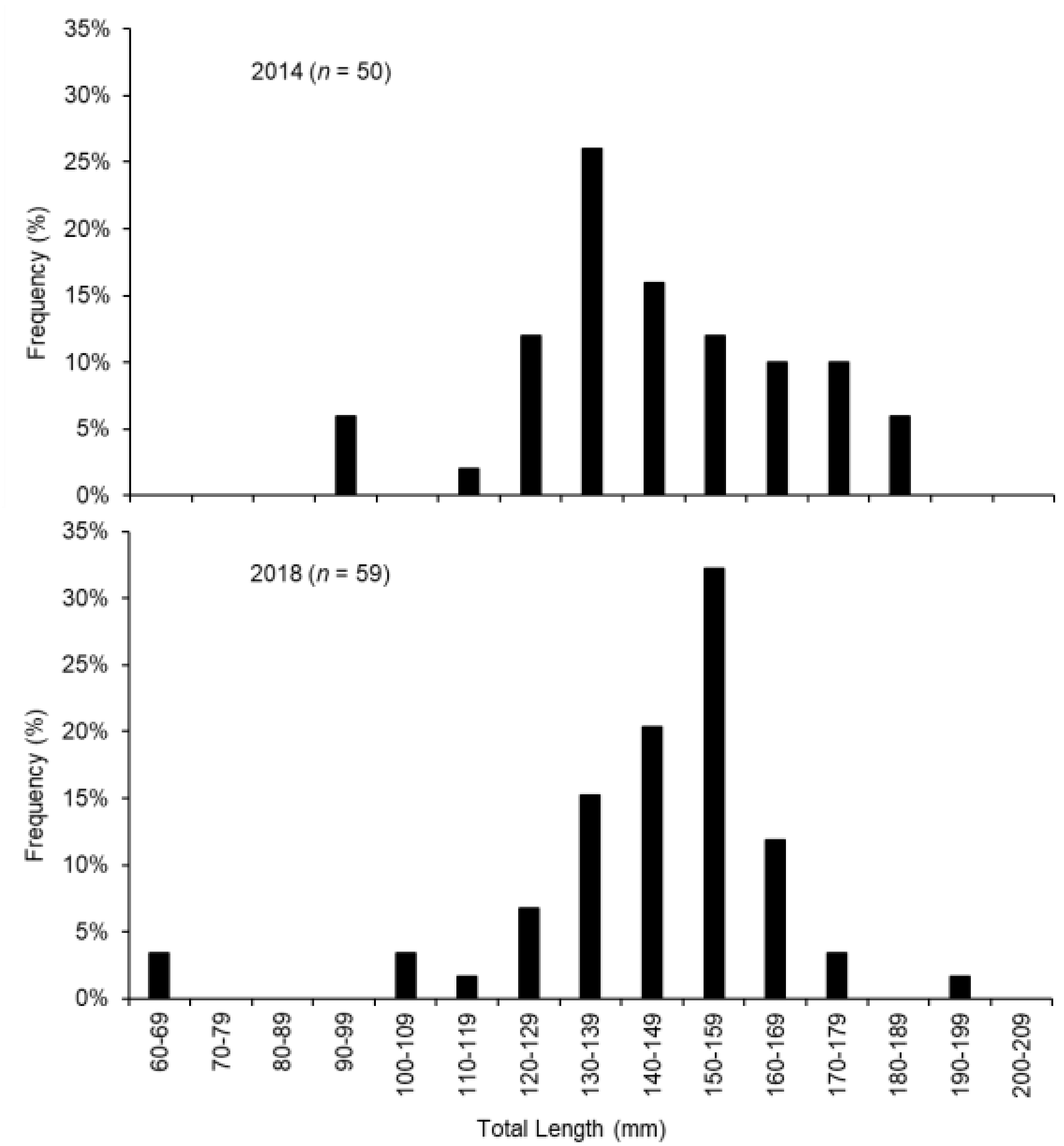

Figure 11. Length-frequency histogram of Bluegill in West Pond via trap net efforts in 2014 (pre-rotenone) and electrofishing efforts in 2018 (post rotenone translocation). Translocation efforts occurred in 2016.

RIVERS AND STREAMS INVESTIGATIONS

AMERICAN WHITE PELICAN PREDATION ON SILVER CREEK TROUT

ABSTRACT

The first reports of American White Pelicans *Pelecanus erythrorhynchos* (hereafter "pelicans") foraging on Silver Creek occurred in 2013. Pelican presence created concern for negative impacts on the wild Rainbow Trout *Oncorhynchus mykiss* and Brown Trout *Salmo trutta.* Several attempts using non-lethal hazing of Pelicans did not deter foraging behavior on the creek. Beginning in the spring of 2018, both Rainbow Trout and Brown Trout, greater than 235 mm in total length, were surgically implanted with radio telemetry tags to determine if the technology could be used to estimate predation by Pelicans and identify where the feeding birds originated. Results from the 2018 telemetry data indicated that Pelicans consumed a minimum of 27% of the tagged trout in Silver Creek and most of the retrieved tags were found on a nesting island at the Minidoka National Wildlife Refuge (Lake Walcott), nearly 100 km south of Silver Creek. Pelicans consumed Rainbow Trout disproportionately to their availability, while consuming Brown Trout in proportion to their availability. Peak predation occurred between late June and mid-July on Silver Creek in 2018.

INTRODUCTION

The abundance of American White Pelicans *Pelecanus erythrorhynchos* (hereafter "pelican") have increased in recent decades in Idaho (Chiaramonte et al. 2019). The increases are generally attributed to the discontinued use of organochlorine pesticides, such as DDT, and to the protections gained following the 1972 Migratory Bird Treaty Act. Along with increases in pelican abundance came more bird predation on Idaho's fisheries (Meyer et al. 2016). Such conflicts have resulted in measurable exploitation of wild and hatchery trout, along with increased social anxiety towards pelicans across Idaho (Meyer et al. 2016).

Pelicans were first documented at Silver Creek in 2013, as a part of the IDFG statewide pelican survey. At the time, it was presumed that the birds had a foraging range ≤100 km. Despite Silver Creek being 93 km from the largest pelican colony in the state (Minidoka), relatively low counts of individuals suggested birds at Silver Creek were foraging in transit between loafing sites (Megargle et al. 2018). However, bird counts have steadily increased at Silver Creek since 2013, coinciding with stable pelican populations across Idaho (IDFG Pelican Management Plan 2016). Recent research has found that pelicans exceed 100 km for foraging (Chiaramonte et al. 2019*)*. In an effort to try to reduce pelican predation, active hazing practices began in 2016, with undocumented success (Megargle et al. 2018). Non-lethal pelican hazing costs approximated $25,000 in 2018.

Methods for estimating bird predation typically involve tagging fish and recovering tags at nesting, roosting, or loafing areas. Such estimates are considered conservative because they do not account for consumed tags that are unrecovered (i.e., tag recovery efficiency). One approach to estimating tag recovery efficiency is by directly feeding birds with fish implanted with passive integrated transponder (PIT) tags and recovering tags deposited at nesting and roosting sites (Osterback et al. 2013; Scoppettone 2014; Meyer et al. 2016). However, estimates that adjust for PIT tag recovery efficiency have exhibited inconsistent variability (Chiaramonte et al. 2019). Such variability increases when evaluating wild fish, because actively feeding tagged fish to pelicans is not possible. Radio telemetry tags are preferred for evaluating pelican exploitation of wild fish stocks because they have detection probabilities greater than 90% and less detection variability (Chiaramonte et al. 2019). Similarly, the high detection probability of radio tags omits the need of a double tag to adjust for unrecovered tags.

The objectives of this study were to determine the predation rate of wild trout by pelicans and to identify the meta-population of pelicans, which forage on Silver Creek. Additionally, we hoped to gain insight on how active non-lethal pelican hazing at Silver Creek plays a role in reducing predation of the wild trout fishery.

METHODS

Fish Tagging

Radio tags (MST-093 Lotek) were surgically implanted into the body cavity of 150 trout by making a small incision into the ventral wall anterior to the pelvic girdle (Hart and Summerfelt 1975). A grooved needle shield was inserted posterior past the pelvic girdle and a 6-gauge needle was inserted between the pelvic girdle and the anal vent using the shielded needle technique to protect internal organs and direct the needle under the pelvic girdle and through the incision on the body wall (Ross and Kleiner 1982). The radio antenna was threaded through the needle so the antenna exited the hole made by the needle. The tag was inserted into the body cavity. The incision was closed using two or three sutures, depending on the length of the incision. Fish were placed in recovery water and monitored for at least 15 minutes, prior to release. These radio tags were equipped with internal motion sensors to emit a mortality signal if the tag had not moved for 12 h, allowing for identification of fish mortalities due to predation or other causes, depending on location and detection history.

Two tag sizes were used (5 g and 10 g) for this study. Tags were not implanted in fish ≤ 235 mm (TL) and no 10 g tags were implanted in fish ≤ 315 mm (TL) to ensure that the tag was not greater than four percent of the fishes total body mass. Tags were dispersed evenly across species with 75 tags in Rainbow Trout *Oncorhynchus mykiss* and 75 tags in Brown Trout *Salmo trutta*. Tagged fish with TL ranging from 150 to 549 mm were released evenly across five study transects at a rate of 15 tagged fish/mile.

Radio Telemetry

To monitor numbers of radio tagged fish, movement, and potential removal by predators, fixed radio receivers (Lotek SRX-DL) were installed at three locations within the Picabo Valley (Figure 12). Additionally, a fixed radio receiver (SRX-DL) was installed at the Minidoka NWR pelican colony to detect the arrival of tagged fish. Receivers were programmed to scan tag-*specific frequencies (150.320, 149.320 Mhz) every six seconds. Each fixed receiver utilized two* 3' (0.91 m) Yagi antennas with four elements, which were affixed in a direction to maximize coverage across the Silver Creek Drainage. Fixed telemetry stations consisted of a radio receiver powered by two 12V batteries housed in a lockable steel box, and maintained by a 24V solar panel ran through a DC power converter.

To evaluate detection probability using the fixed receivers at Silver Creek and the variability in detection strengths of in-stream fish, out of water fish, and predated fish, we compared the range and mean detection strength of a tag at 25 randomly selected test locations using a paired *t*-test ($\alpha = 0.05$). Detection strengths are described as total and mean Hz. At all test locations, a 10 g tag (150.320.084) was extended 9 m above the ground using a pole (exposed tag). Time was recorded at all test locations to compare with the receiver's time stamp detection. All receivers were downloaded and cleared, followed by a subsequent test at each location; where a 10 g tag and antenna were placed inside a 335 mm Rainbow Trout carcass, and then stuffed into a thawed chicken carcass (in-carcass tag) to mimic a tagged fish inside a pelican. The carcass was attached to a pole using bailing twine and hoisted 9 m in the air. The range, mean, and standard error were determined for each test detection type (out of water and predated) and compared with instream detections from all three Silver Creek fixed receivers of living (swimming) tagged fish from the same day.

An aerial telemetry flight was conducted after pelicans had left the region for the season on October 12, 2018 to determine if there were tags deposited outside of the Minidoka colony. The flight plan included the entire Snake River from C.J. Strike Reservoir to American Falls Reservoir, Silver Creek, and all adjacent lentic waters; including Bruneau Pond, Dunes Lake, Carey Lake, Murtaugh Lake, Magic Reservoir, Mormon Reservoir, Mountain Home Reservoir, Indian Creek Reservoir, and Blacks Creek Reservoir. Aerial detection utilized a Lotek SRX-400 receiver set at a six-second time interval and dual mounted H-antennas. Additionally, to determine detection probability, flight-tracking data was compared to an inventory mobile tracking event via canoe on October 11, 2018. Canoe telemetry tracking utilized a Lotek SRX-400 receiver set at a six second time interval, and equipped with a three element handheld Yagi antenna.

Data analysis

A minimum estimate of predation by pelicans was calculated by dividing the number of radio tags recovered or detected outside of the Silver Creek Valley by the number of tags released. Variances for these proportions (Thompson 2012) were calculated using the formula:

$$Var(proportion) = \frac{P(1-P)}{n-1}$$

where P is the proportion of recovered tags and n is the number of stocked tags. Ninety-five percent confidence intervals were calculated accordingly. A paired *t*-test (α = 0.05) was used to compare numbers of small and large tagged fish preyed upon. Because some overlap in fish lengths occurred between the two groups, we also tested size selectivity by comparing cumulative length frequency distributions of stocked versus eaten fish using a Kolmogorov-Smirnov test (α = 0.05). Pelican prey selectivity of trout species was evaluated using the Strauss's prey selectivity index (1979):

$$L = r_i - p_i$$

where r_i and p_i represent the relative abundance of Rainbow Trout and Brown Trout available in the environment, respectively. Relative prey abundance (r_i) was determined by dividing the number of predated Rainbow Trout and Brown Trout, by the total number of predated fish. The proportion of each trout species in the environment (p_i) were calculated by dividing the total predated Rainbow Trout and Brown Trout by the total of each trout species sampled in Silver Creek. Strauss's index value (L) can range from total avoidance (-1) to absolute selectivity (1) for a given prey item. Prey items with index values between 0.15 and -0.15 represent prey consumed proportionately to their availability. We defined prey species selectivity as values > 0.15 or < -0.15 (Thiessen et al. 2018).

RESULTS

In total, 150 telemetry tags were deployed from April 1 - May 5, 2018. Large (10 g) and small (5 g) tags were distributed evenly across 10 miles of stream at a rate of 15 tags/mile. The mean length of tagged Rainbow Trout and Brown Trout released was 354 and 398 mm, respectively. Combined mean total length (± 90% CI) of released trout was 365 mm (± 2). Species composition for tagged fish was 51% (n = 77) Rainbow Trout and 49% (n = 73) Brown Trout.

Thirty-seven tags were detected at the Lake Walcott receiver location. Three additional tags emitting mortality signals were located in pelican loafing ponds adjacent to Silver Creek near Tic-Toc Ranch. These tags were attributed to pelican predation based on their final resting location and signal strength history prior to emitting a mortality signal. An additional three tags remained unaccounted for post release, and were not categorized as eaten fish. Combined across Rainbow Trout and Brown Trout, we estimated pelican predation was a minimum of 27% (n = 40) of tagged trout in Silver Creek. The species-specific predation rate of RBT (n = 23) and BRN (n = 17) by pelicans was 30% and 23%, respectively

Pelicans consumed significantly smaller fish compared to the mean size of tagged and released fish (t = 3.74 P = 0.0001). The mean total length for Rainbow Trout and Brown Trout consumed by pelicans was 308 (± 6; Figure 13) and 337 mm (± 5; Figure 13), respectively. Across all tag release zones, 58% of trout eaten by pelicans were Rainbow Trout (*n* = 23) while 42%

were Brown Trout (*n* = 17). Strauss's selectivity index value for Rainbow and Brown Trout was *L* = 0.51 and *L* = -0.17, respectively (Figure 14), suggesting that pelicans consumed Rainbow Trout at a higher rate than their availability but not Brown Trout. Based on tagging release locations, the majority of pelican predation came from two release zones: 35% (*n* = 14) from zone 2 (Kilpatrick Pond to Hwy 20 Bridge), and 30% (*n* = 12) from zone 4 (John French Bridge to Picabo Bridge; Figure 15).

Mobile tracking on Silver Creek via canoe encountered 110 unique radio tags. The mean (± 90 % CI) in-stream tag detection strength was 125 Hz (± 5). Subsequent aerial mobile tracking across the Silver Creek Valley encountered 27 unique tags. The aerial tag detection rate at Silver Creek was 25%. Similarly, aerial mobile tracking encountered four of the 37 tags present at Lake Walcott resulting in an 11% detection rate.

Fixed telemetry receivers (*n* = 3) detected all tag types (exposed tag and tags implanted inside a fish and chicken carcass) at all 25 locations. Receiver 1 and 3 detected all tag check efforts. Receiver 2 detected 20 of the 50 tag check efforts. The mean detection strengths for exposed and in-carcass tags from fixed receivers were 213 (± 4) and 153 Hz (± 8), respectively. Signal strength between tags detected in swimming live trout and detections from tag check locations differed significantly (t = 9.34, P = < 0.0001). Signal strength of exposed tags out of water and in-carcass tags also significantly differed (t = 7.38, P = < 0.0001).

May and June exhibited the lowest predation on trout species by pelicans during the evaluation. Pelican predation was highest in July and represented more than 60% of consumed tagged fish (Figure 16).

DISCUSSION

While we estimated the minimum pelican predation rate was 27% across both trout species – with 30 % for Rainbow Trout and 23% for Brown Trout – predation rates are likely much higher for trout between 225 and 375 mm TL. We calculated the overall pelican predation estimate based on the entire size range of tagged wild trout released back into Silver Creek. Length data of consumed trout indicate pelicans did not consume any trout over approximately 375 mm (Figure 13). If we consider the tagged trout >375 mm TL as being unavailable to predation, consumption rates on susceptible trout between 225 and 375 mm TL would be much higher, potentially exceeding typical annual mortality rates of 40% (Schill 1994). Our results suggest that pelicans are exploiting Silver Creek's wild trout at a higher rate than average estimates of avian predation on hatchery Rainbow Trout (18%; Meyer et al. 2016), which are thought to be naive and more susceptible to predation than wild trout (Berejikian 1995; Meyer et al. 2016). The higher than anticipated pelican predation rates may be due to Silver Creek's proximity to the Minidoka colony at Lake Walcott; Idaho's largest White Pelican colony (IDFG 2016). Meyer et al. (2016) found that Idaho waters ≤ 100 km from a pelican colony experience the highest rates of pelican exploitation for hatchery Rainbow Trout (ranging from 20-80%). Silver Creek is 89 km from the Minidoka colony. Additionally, aerial mobile tracking flights did not find any eaten tags outside of the Silver Creek Valley, or away from the Minidoka colony; suggesting that identified pelican predation occurring at Silver Creek is attributed to the Minidoka colony.

Our results support that American White Pelicans are predating wild trout populations in Silver Creek similarly to previously documented studies (Meyer et al. 2016). It is unclear if predation levels are high enough to precipitate declines in Rainbow Trout and Brown Trout abundances. Angler exploitation and use evaluations would help identify the proportion of annual mortality that anglers are contributing to these populations. An estimate of total annual mortality parsed out into natural, angler and pelican mortality, would allow us to determine if increased efforts are necessary to maintain the wild trout populations on Silver Creek.

This study documented pelicans consuming Rainbow Trout and Brown Trout disproportionately to each species availability, based on Strauss's selectivity index values (Figure 14). Pelicans consumed Rainbow Trout at a higher rate than what was generally available in the trout population, while consuming Brown Trout slightly less than their availability. This may be a result of behavioral differences between the species, where Rainbow Trout suspend higher in the water column, making them more susceptible to avian predation than other salmonids (Matkowski 1989; Meyer et al. 2016). Selectivity by pelicans on Rainbow Trout is concerning, considering previous trend monitoring efforts at Silver Creek have documented a decrease in the relative abundance of Rainbow Trout and species composition recently skewed towards Brown Trout (Stanton et al. 2016). The results from the sample collected in this study supports a similar species catch composition (34% RBT, n = 95; 66% BRN, n = 182). If Rainbow Trout are experiencing higher rates of mortality from avian predation, this could exacerbate the species composition shift towards Brown Trout.

Previous Idaho studies evaluating pelican predation on wild trout did not note prey size selectivity, but rather documented differences in prey size ranges between avian predators (Meyer et al. 2016). Similarly, multiple Idaho reports evaluating the impacts of pelican predation on hatchery trout noted size of fish released and consumed did not significantly differ (Meyer et al. 2016; Chiramonte et al. 2018). Despite concurring results across studies, pelicans have been shown to display prey selectivity towards hatchery sized trout post stocking (Derby and Lovvern 1997). Our study documented that the mean total length of tagged trout consumed (308 mm) was significantly shorter than tagged trout released (365 mm) (t = 3.74 P = 0.0001). The mean length of Rainbow Trout consumed in this study (308 mm) is similar in size to current IDFG hatchery Rainbow Trout size-at-release objectives (306 mm; Cassinelli 2016). Our findings concur with past studies suggesting pelicans may exhibit some level of prey selectivity towards hatchery-sized wild trout.

Pelican foraged throughout the Silver Creek study area. However, 65% (n = 26) of all consumed fish were released in two zones (Kilpatrick Pond and John French's property). Both zones pose challenges to the non-lethal hazing activities. The Nature Conservancy, which currently prohibits active hazing practices, manages both zones. Additionally, pelican foraging at both zone locations had limited human disturbance because these zones are the only two sections of Silver Creek that are solely accessible by wade and/or boat angling, suggesting that pelicans are actively selecting areas to feed with less human presence.

Aerial mobile tracking had poor tag detection probability compared to tracking via canoe. Canoe tracking detected all of the tags previously detected by fixed receivers, while Aerial tracking detected only 11% of known tags. Receiver settings were the same for both tracking strategies. Low detection rates via aerial tracking are likely due to six-second tag detection intervals, where the rate of detection pings from the receiver every six-seconds and the delay of omni-signal from the tag is too infrequent (5.5 - 7 seconds) to consistently detect tags by a fixed wing aircraft travelling at the slowest possible speeds. A two-second receiver detection interval might increase tag detection rates in future evaluations.

Three radio tags went undetected shortly after release. We assumed these tags failed due to discontinued detections two weeks post release, without any subsequent detection from another receiver or tracking event. Lotek reports a two percent tag failure rate with mini-tags, which fits within the bounds of our unaccounted tags. However, it is possible that all or a proportion of unaccounted tags were displaced outside the study area by pelicans and we did not detect them via aerial tracking.

Detection strength between consumed tags and available tags was significantly different. However, the range in detection strengths overlapped across detection types making it difficult to differentiate whether an individual tag had been consumed and/or removed from the creek, based on tag detection strength alone. Tag detection probability across the Silver Creek study area, at fixed receivers, was 100%. Therefore, we feel confident that if a tag was in Silver Creek at the end of the study time period (when pelicans had migrated for the season), we had accounted for it.

Pelican counts at Silver Creek appear to be consistent across years, since 2013. Non-lethal hazing strategies have been variable. Hazing activities appeared to show a benefit to reducing fish predation in 2018 by reducing the numbers of fish consumed during May and June when active non-lethal hazing occurred (Figure 16). However, immediately after hazing ceased, predation peaked, during the month of July. This increase of predation may also align with the timing of pelicans highest caloric intake needs, which peak in the month of July based on optimal chick hatch timing (IDFG 2016). Pelican eggs require parental incubation, limiting the forage potential of a breeding pair of pelicans to one parent (IDFG Pelican Management Plan 2016). Most pelican chicks in Idaho hatch in July, allowing both parents to forage simultaneously from that point forward. July represents the highest pelican foraging efforts on Idaho fisheries because of these breeding characteristics and the caloric requirements of newly hatched chicks (IDFG Pelican Management Plan 2016).

RECOMMENDATIONS

1. Repeat the predation radio telemetry study in 2019.

2. Estimate the proportion of fishing and natural mortality rates of trout to better understand the relative significance of pelican predation in driving trout populations.

3. Review the non-lethal hazing methods that have been used through 2018 and evaluate the effectiveness of these methods. Can improvements to these techniques reduce overall predation of wild trout in areas where non-lethal hazing has not occurred (i.e. TNC and private lands)?

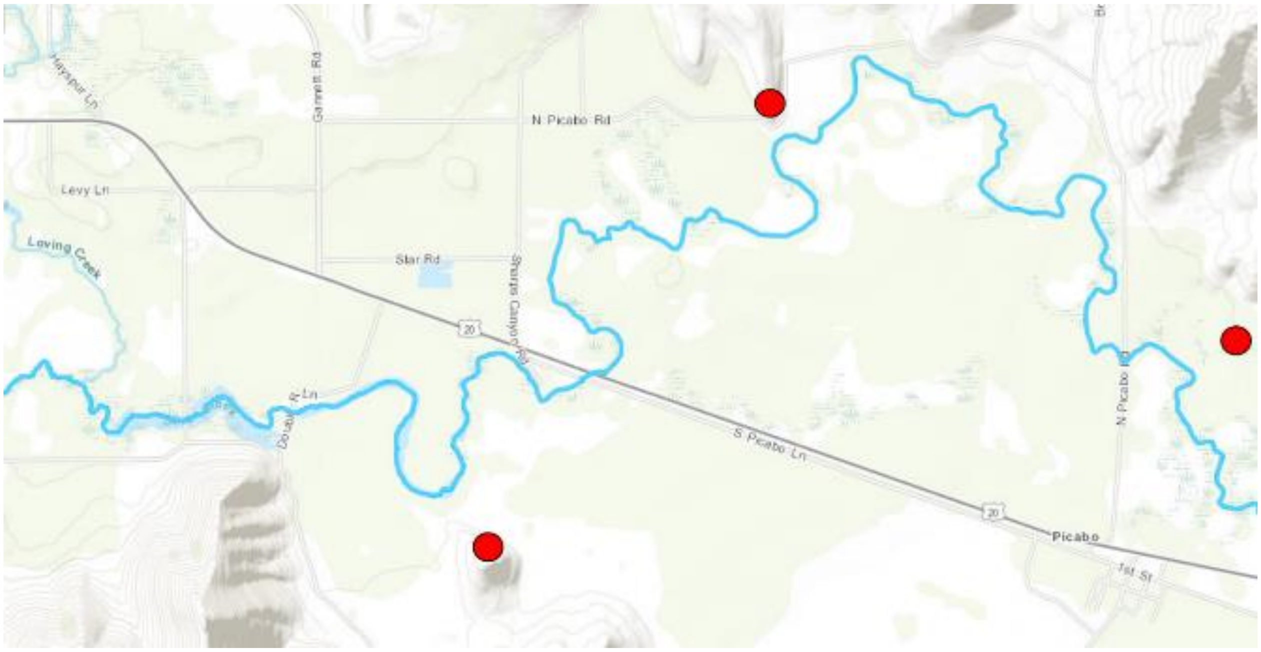

Figure 12. Stationary receiver locations used to detect radio telemetry tags in tagged wild trout in Silver Creek, ID within the Picabo Valley (indicated by red dots).

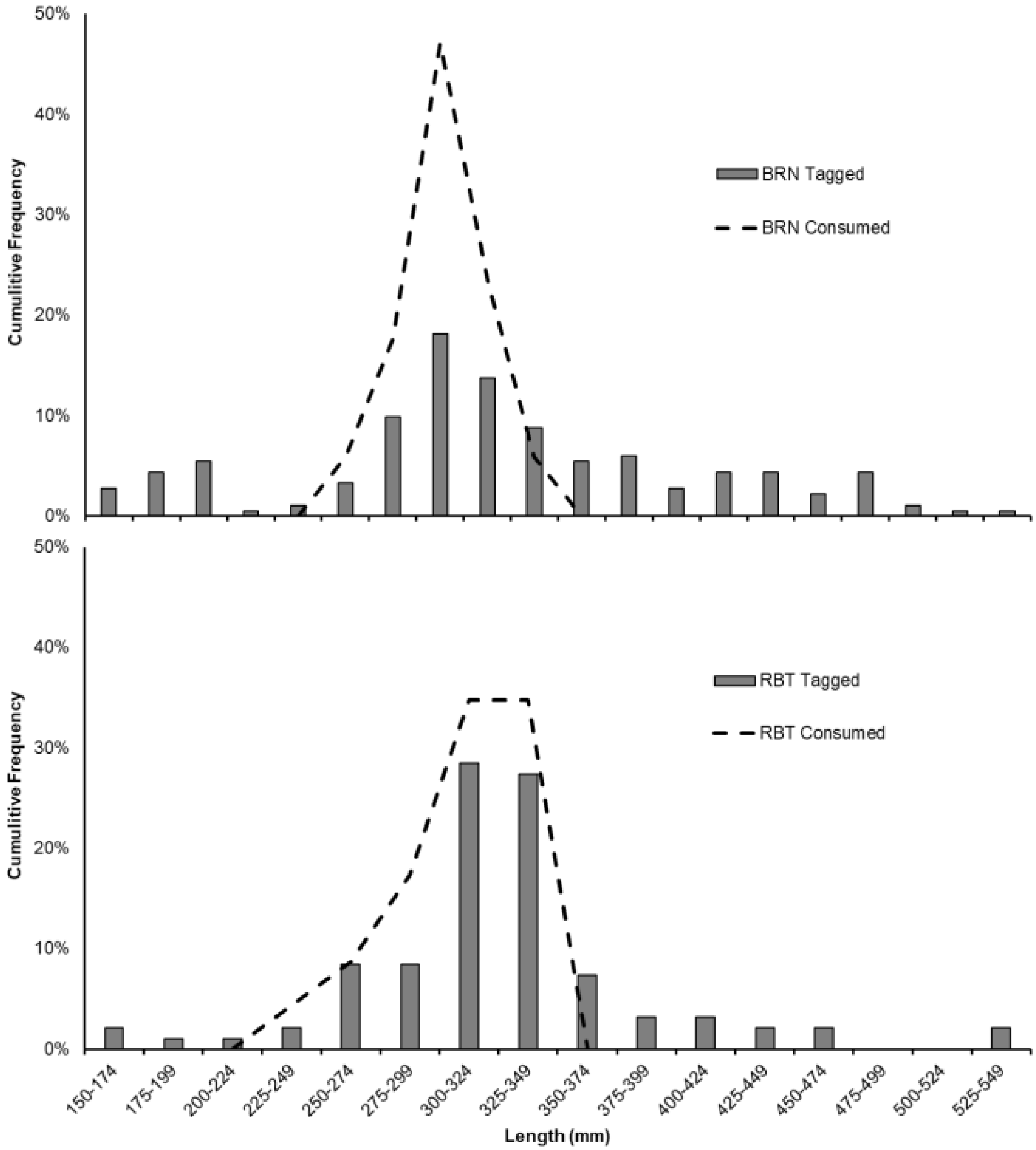

Figure 13. Length frequency distribution of tagged and released Brown Trout (BRN) and consumed Brown Trout (BRN) by total length; and tagged and released Rainbow Trout (RBT) and consumed Rainbow Trout (RBT) by total length.

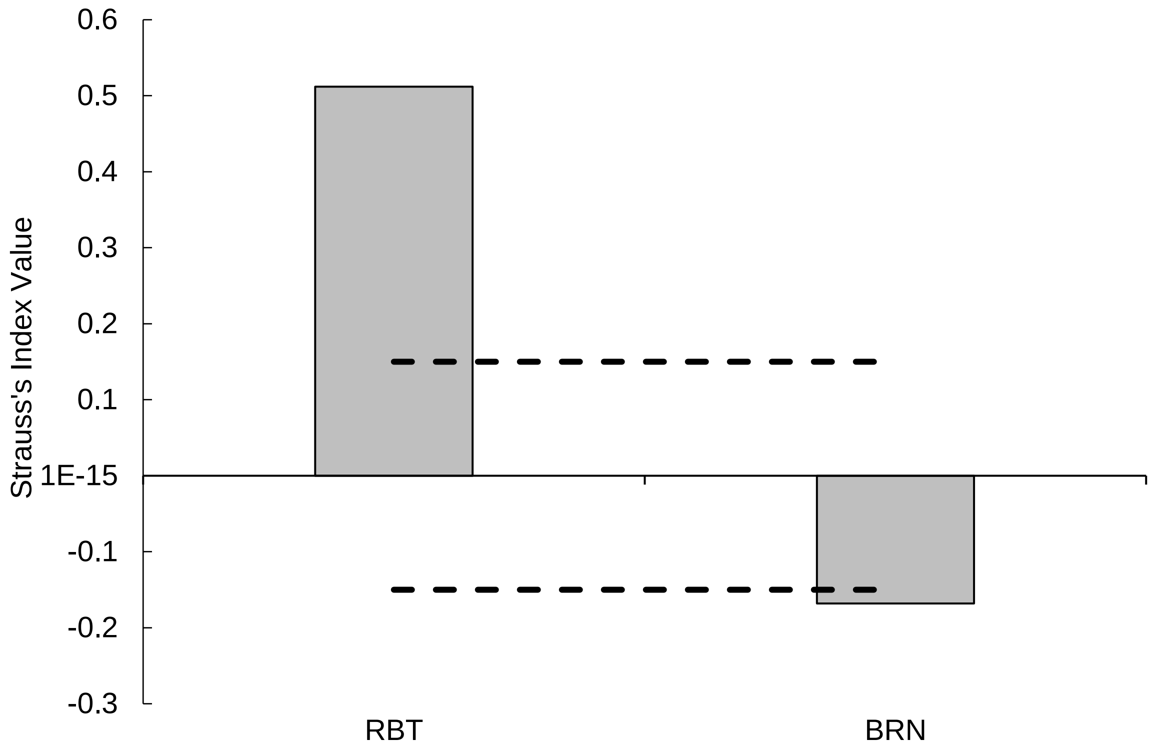

Figure 14. Selectivity index comparing opportunistic verse selective prey species (Rainbow Trout = RBT and Brown Trout = BRN) foraging by pelicans at Silver creek. Values ≤-0.15 suggest prey avoidance based on prey availability. Values ≥ 0.15 suggest prey selectivity based on prey availability.

Figure 15. Radio telemetry tag deployment across Silver Creek; orange represents the areas with the highest predation values (60% of total estimated predation). Tagged fish were distributed evenly throughout each of the colored sections.

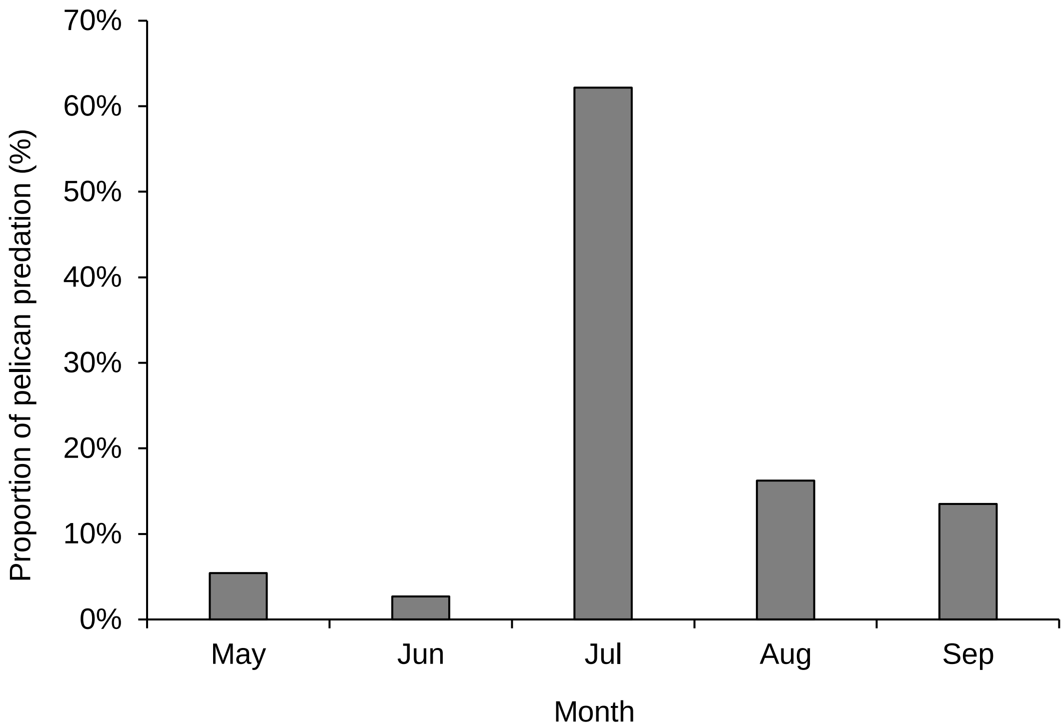

Figure 16. Proportion of trout predation attributed to American White Pelicans in Silver Creek, near Picabo, ID by month.

BIG WOOD RIVER POPULATION TREND MONITORING

ABSTRACT

The Big Wood River provides a popular fishery with angling opportunities for Rainbow Trout *Oncorhynchus mykiss*, Brown Trout *Salmo trutta*, Brook Trout *Salvelinus fontinalis*, and Mountain Whitefish *Prosopium.* The fishery is managed through a mosaic of regulations and boundaries originally implemented beginning in 1977. The Idaho Fish and Game completes periodic trend monitoring on the Big Wood River via electro fishing and mark/recapture population estimates. Collectively, 1,935 fish were collected in the Big Wood River during the mark and recapture runs in 2018. The mean total length for all trout and Mountain Whitefish in the Big Wood River was 238 (± 4; 90% CI) and 304 mm (± 19), respectively. Species composition consisted of 88% Rainbow Trout, 6% Brown Trout, 5% Mountain Whitefish, and 1% Brook Trout. Recapture efficiency for Rainbow Trout, Brown Trout, and Brook Trout collectively was 22% and Mountain Whitefish was 37%. Total trout (≥ 100 mm) abundance for the Big Wood River was estimated at 1,736 RBT/km (± 178; 90% CI). Mountain Whitefish (≥ 100 mm) abundance for the Big Wood River was estimated at 127 MWF/km (± 18 90% CI). Collectively, the wild rainbow trout population for the Big Wood River appears to be stable, despite slight increases in growth rates and densities compared to previous estimates. Brown Trout density and range increased throughout the drainage in 2018 compared to all previous estimates. Simultaneous declines in Mountain Whitefish and Brook Trout were observed in 2018 as well.

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INTRODUCTION

The Big Wood River drainage originates in the Smokey, Boulder, and Pioneer Mountains of South Central Idaho. The river flows south from its origin to its confluence with the Little Wood River west of Gooding, Idaho, forming the Malad River. The river is impounded by Magic Dam, located west of State Highway 75, and forms Magic Reservoir. Downstream from the dam, the water is used extensively for irrigation and the river is often dewatered seasonally, with the entire discharge being diverted into the Richfield Canal.

The Big Wood River above Magic Reservoir provides a popular trout fishery with angling opportunities for Rainbow Trout *Oncorhynchus mykiss*, Brown Trout *Salmo trutta*, Brook Trout *Salvelinus fontinalis*, and Mountain Whitefish *Prosopium williamsoni*. The Big Wood River has been managed through a mosaic of fishing regulations and boundaries, originally implemented in 1977 (Thurow 1987). These regulations are complex and anglers report they are hard to comprehend. Currently, the upper Big Wood River (upstream of Magic Reservoir) has five different boundaries separating four regulation strategies. Within the different boundaries, three unique date ranges dictate fishing closures, harvest closures, and gear type restrictions. The uppermost and lowermost regulation boundaries on the Big Wood River are managed using Magic Valley Regional general fishing regulations, which allow for harvest of up to 25 Brook Trout, 6 Rainbow and/or Brown Trout, and 25 Mountain Whitefish per day. The Idaho Department of Fish and Game (IDFG) trend monitoring sites represent three different regulation sections on the Big Wood River. These regulation sections include a restrictive slot limit on trout, with no harvest between 305 mm and 406 mm (Hailey), a catch-and-release only section (Gimlet), and a general regulation section (Boulder). Additionally, hatchery supplementation occurs in both the uppermost and lowermost sections of the Big Wood River upstream of Magic Reservoir; and corresponds with the general regulation boundaries.

The Big Wood River was monitored as part of the triennial survey design at the three uppermost regulation boundaries. Local angling constituents and the contentious regulatory history make long-term monitoring on the Big Wood River important for evaluating population trends and ensuring the current fishing regulations are meeting the intended fishery management objectives and producing the desired fishery. The objective of this evaluation was to continue the trend monitoring efforts and to estimate Rainbow Trout *Oncorhynchus mykiss*, Brown Trout *Salmo Trutta*, Brook Trout *Salvelinus fontinalis*, and Mountain Whitefish *Prosopium williamsoni* populations to inform management decisions.

METHODS

Fish were collected with an inflatable electrofishing canoe, fitted with two mobile anodes, and connected to 15-m cables. The cathodes consisted of three octopus cable bars that totaled 1.5 m in length and consisted of 15 cable danglers. The inflatable canoe carried a 5,000-W generator (Honda EG5000X), a Midwest Lake Electrofishing Systems (MLES) Infinity electrofishing control box, and a live well for holding fish. Oxygen was pumped into the live well (2 L/min) through a fine bubbler air-stone. Pulsed direct current (DC) was produced by the generator. Settings were 24% duty cycle, 60 pulses per second, 300-400 volts, producing 1,000-2,000 W. Two people operated the mobile anodes and one person guided the canoe and operated the control box, which included the safety switch and controlled the output. The remaining seven people were equipped with dip nets and captured stunned fish. All trout and Mountain Whitefish were placed in the live well. When the live well was at capacity, the crew stopped at the nearest riffle and processed fish.

Rainbow Trout, Brown Trout, Brook Trout, and Mountain Whitefish were sampled at three sites during September 2018. Marking runs were conducted on September 11, 12, and13 at the Boulder, Gimlet, and Hailey reaches, respectively (Figure 16). Recapture runs occurred on September 18, 19, and 20 at the Boulder, Gimlet, and Hailey reaches, respectively. Discharge was approximately four m^3/s. Site length was determined from 1:24,000 topographic maps. Mean wetted width was calculated using 10 widths from each site measured with a hand-held laser range finder (Leupold RX series). Site area was estimated by multiplying the calculated mean widths over a section and by the section length. For braided channels, mean width was measured across the river excluding any distances across islands.

Fish were marked with a 7-mm diameter hole from a standard paper punch with an upper, middle, or lower caudal fin punch corresponding to the upper, middle, and lower sites, respectively. Differential marking allowed assessment of inter-site movement. Only fish longer than 100 mm were marked. Fish were measured for total length (mm) and a subset were weighed (g). Fish were released 50 to 100 m upstream from the processing site to reduce the potential of movement out of the site or into areas still to be electrofished. During the recapture effort, all trout and whitefish greater than 100 mm were captured and placed in the live well. Fish were examined for marks on the caudal fin. All fish were measured for total length (mm).

Species composition was expressed as percent of total catch from the marking run, and was calculated by dividing the total number of each species captured by the total number of target species captured. Proportional confidence intervals were calculated using Fleiss (1981).

Fisheries Analysis + (FA+) software was used to generate mark-recapture and electrofishing capture efficiency estimates (MFWP 2004). To account for selectivity of electrofishing gear, population estimates (*N*) were calculated using a maximum likelihood estimation to fit the recapture data. A capture probability function of the form

$$Eff = (exp(-5+\beta_1 L+ \beta_2 L^2)) /(1+ exp(-5+\beta_1 L+ \beta_2 L^2))$$

where *Eff* is the probability of capturing a fish of length *L*, and β_1 and β_2 are estimated parameters (MFWP 2004). Then *N* is estimated by length group where M is the number of fish marked by length group:

$$N = M / Eff$$

Population estimates (*N*) were calculated for each site separately, and in addition pooled for a comprehensive estimate expressed as # fish/km, for comparison to surveys from previous years. Observed mortalities during the marking run were recorded and excluded from the population estimates.

The number of marked fish by site and recapture efficiency were also calculated to assess and compare the basic components of the 2018 survey to previous years. Recapture efficiency (R_{eff}) was simply calculated as:

$$R_{eff} = R/C$$

where *R* is the number of recaptures collected and *C* is the total number of fish collected during the recapture run.

Relative weight (W_r) for individual RBT ≥ 120 mm were estimated by using the following equation (Simpkins and Hubert, 1996):

$$Wr = \frac{W}{Ws} X\, 100$$

where W_r is the relative weight, W is the weight of fish in g, and W_s is the length specific standard weight. W_s was estimated using the following equation (Blackwell et al. 2000):

$$Log_{10}(Ws) = a + b(Log_{10}L)$$

where W_s is the length specific standard weight, a is the minimum relative standard weight, b is the maximum relative standard weight, and L is the individual fish length in mm.

Otoliths were collected from a subsample of Rainbow Trout (n = 83) for all sample transects.

RESULTS

Hailey Transect

A total of 337 Rainbow Trout, 56 Brown Trout, 6 Brook Trout, and 9 Mountain Whitefish were collected in the Hailey transect during the marking run. A total of 440 Rainbow Trout, 48 Brown Trout, 3 Brook Trout, and 11 Mountain Whitefish were collected in the Hailey transect during the recapture run. Species composition (Figure 17) consisted of 83% Rainbow Trout (RBT), 14% Brown Trout (BRN), 1% Brook Trout (BRK), and 2% Mountain Whitefish (MWF). Recapture efficiency (R_{eff}) for all trout and length bins was 19%. Too few Brook Trout and Mountain Whitefish (≥ 100 mm) were collected to conduct a mark/recapture population estimate, and thus capture efficiency for these species were not calculated. The Rainbow Trout (≥ 100 mm) abundance estimate (± 90% CI) for the Hailey transect was 2,422 fish/km (± 206; Figure 18). The Brown Trout (≥ 100 mm) abundance estimate (± 90%CI) in the Hailey transect was 53 fish/km (± 7; Figure 18).

The mean total length (± 90% CI) for Rainbow Trout, Brown Trout, and Brook Trout in the Hailey transect was 209 (± 3), 206 (± 13), and 162 mm (± 14), respectively (Figure 18). The mean total length for Mountain Whitefish was 177 ± 22 mm. Mean relative weight for Rainbow Trout at the Hailey transect was 85 (Figure 20). Otoliths were collected from a subsample of Rainbow Trout (n = 29) for the Hailey Transect. There were five age classes represented (Figure 24). Mean length at age-1 through age-4 was 171 (± 21), 258 (± 27), 362 (± 31), and 392 mm (± 68), respectively. There was only one otolith sample representing an age five fish, which had a length of 437 mm.

Gimlet Transect

A total of 327 Rainbow Trout, 3 Brown Trout, 3 Brook Trout, and 21 Mountain Whitefish were collected in the Gimlet transect during the marking run. A total of 277 Rainbow Trout, 5 Brown Trout, no Brook Trout, and 11 Mountain Whitefish were collected in the Gimlet transect during the recapture run. Species composition during the marking run consisted of 93% Rainbow Trout, 5% Mountain Whitefish, and 2% Brown Trout (Figure 17). Due to the limited encounter rates, Brook Trout (n = 3) were not marked. Recapture efficiency for Rainbow Trout, Brown Trout, and Mountain Whitefish was estimated at 22%, 25%, and 27%, respectively. The Rainbow Trout and Brown Trout (≥ 100 mm) abundance estimates for the Gimlet transect were 2,157 (± 194; Figure 3) and 5 fish/km (± 1; Figure 21), respectively. The Mountain Whitefish (≥ 100 mm) abundance estimate for the Gimlet transect was 36 fish/km (± 9; 90% CI).

The mean total length for Rainbow Trout, Brown Trout, and Mountain Whitefish in the Gimlet transect was 276 (± 3), 351 (± 50), and 340 mm (± 16), respectively (Figure 21). Mean relative weight of Rainbow Trout was 91 (Figure 20). Otoliths were collected from a subsample of Rainbow Trout (*n* = 27) for the Gimlet Transect. There were five age classes represented (Figure 24). Only two age-1 fish were collected, with lengths of 119 mm and 165 mm. Mean length at age-2 through age-4 were 236 (± 16), 314 (± 19), and 413 mm (± 14), respectively. Only two age-5 fish were collected with lengths of 415 and 439 mm.

Boulder Transect

A total of 190 Rainbow Trout, 1 Brown Trout, 2 Brook Trout, and 27 Mountain Whitefish were collected in the Boulder transect during the marking run. A total of 137 Rainbow Trout, no Brown Trout, 1 Brook Trout, and 19 Mountain Whitefish were collected in the Boulder transect during the recapture run. Species composition consisted of 86% Rainbow Trout, 12% Mountain Whitefish, 1% Brown Trout, and 1% Brook Trout (Figure 17). Due to limited encounter rates, Brook Trout (*n* = 3) and Brown Trout (*n* = 1) were not marked. Recapture efficiency for Rainbow Trout and Mountain Whitefish was 34% and 30%, respectively. The Rainbow Trout (≥ 100 mm) abundance estimate (± 90% CI) for the Boulder transect was 657 fish/km (± 61; Figure 22). The Mountain Whitefish (≥ 100 mm) abundance estimate for the Boulder transect was 352 fish/km (± 33; Figure 22).

The mean total length for Rainbow Trout, Brook Trout, and Mountain Whitefish in the Boulder transect was 247 (± 5), 128 (± 11), and 334 mm (± 13), respectively (Figure 22). Mean relative weight for Rainbow Trout was 88 (Figure 20). Otoliths were collected from a subsample of Rainbow Trout (*n* = 27) for the Boulder transect. There were four age classes represented (Figure 24). Mean length age-1 through age-4 was 209 (± 77), 250 (± 41), 322 (± 42), and 400 mm (± 43), respectively.

Combined

A combined total of 854 Rainbow Trout, 52 Brown Trout, 11 Brook Trout, and 58 Mountain Whitefish were collected across all marking runs. A combined total of 853 Rainbow Trout, 61 Brown Trout, 4 Brook Trout, and 40 Mountain Whitefish were collected across all recapture runs. Species composition consisted of 88% Rainbow Trout, 6% Brown Trout, 5% Mountain Whitefish, and 1% Brook Trout. Recapture efficiency for all trout and Mountain Whitefish was 22% and 37%, respectively. The Rainbow Trout (≥ 100 mm) abundance estimate for the Big Wood River was 1,736 fish/km (± 178; 90% CI). Mountain Whitefish (≥ 100 mm) abundance estimate for the Big Wood River was 127 fish/km (± 18).

DISCUSSION

Age-1 and age-2 Rainbow Trout primarily dominate the length frequency within the Hailey reach, which is typical of wild trout populations. The regulations allow harvest of fish, except those between 305 and 406 mm within the reach. Rainbow Trout are reaching 305 mm by approximately age-3, and exceeding the slot limit maximum length (406 mm) by age-4. This estimate did not document any age-6 and very few age-5 trout when compared to 2009 and 2012 data. However, age-4 trout from the 2018 estimate matched or exceeded the TL of age-5 and age-6 fish from the previous two estimates. Additionally, past estimates noted lower densities of Rainbow Trout and slower growth rates (Megargle et al 2019), suggesting productivity in the Big Wood River has potentially increased between efforts. Length infinity estimates suggest RBT in the Big Wood River could attain lengths slightly greater than 500 mm. There were very few RBT exceeding 406 mm encountered in all surveys from 2006 to present, with low numbers of those fish nearing 500 mm in TL. Growth rates observed for Rainbow Trout in 2018 were similar to the 2006 survey, when densities were much lower. Slot limit regulations appear to be working within the Hailey reach based on the size structure data from this survey.

The Hailey reach has experienced a decline in Brook Trout density since 2012 and a simultaneous increase in Brown Trout density. This transition may be a result of multiple variables. One explanation may be interspecies competition favoring Brown Trout, which generally grow faster and larger than Brook Trout. Additionally, landslides associated with the Beaver Creek fire in fall of 2013 may have negatively affected Brook Trout recruitment. At the same time, additional nutrient loading into Magic Reservoir may have benefitted the adfluvial Brown Trout populations.

The Gimlet reach appears to have a relatively robust trout population. This is the only section of the Big Wood River that has exclusively catch-and-release regulations. The lack of harvest from within the reach likely explains why Rainbow Trout in the Gimlet transect have the highest mean length and the highest proportion of species composition among the three sample reaches. Similar to the Hailey section, we observed a significant increase in the Rainbow Trout population during the 2018 survey when compared to previous surveys. This may be due to excellent water conditions following the winter of 2017-2018. Rainbow Trout length distribution within the Gimlet reach suggest that rainbows rarely obtain lengths greater than 406 mm (16 inches), despite being a catch and release only section. Growth rates of Rainbow Trout throughout the Gimlet section were similar to past surveys, and are likely limited due to the low productivity commonly associated with freestone trout rivers. Brown Trout abundance remains low in the Gimlet reach. However, this study observed an increase in encounter rates of Brown Trout, which may be a response to consecutive good water years and the species pioneering further upstream in the drainage.

The Boulder transect is the upper most reach in the study area and exhibits a complex set of rules associated with the section. There is a six trout daily limit between the Saturday before Memorial Day and November 30 of each year, it is a catch-and-release fishery from December 1 through March 31, and it is closed to all fishing from April 1 through the Friday before Memorial Day. Collectively, the Boulder section provides the most liberal harvest regulations among the three regulation sections on the Big Wood River and therefore receives approximately 3,500 catchable (hatchery trout 9-13 inches in TL) Rainbow Trout annually to supplement wild Rainbow Trout harvest. Previous estimates of catchable Rainbow Trout harvest completed in 2014 from within the section indicated that harvest was minimal at 2% (unpublished data, IDFG). Additional tagging should be done to evaluate whether or not hatchery Rainbow Trout are being utilized within the reach. Furthermore, the proportion catch attributed to Mountain Whitefish is similar to past surveys (2012; Megargle et al. 2019), conducted in 2009 and 2012. The Boulder section typically has the highest densities of Mountain Whitefish within the three trend sections and remains a stronghold for the species within the Big Wood River complex.

Collectively, the Big Wood River has a stable wild Rainbow Trout population. Densities of wild trout remain high despite the potential increases in growth rates observed in 2018; which are typically associated with lower densities of trout. There are few fish greater than 406 mm (16 inches) across all study reaches, which is a common concern expressed by local anglers. The Big Wood River wild trout population exhibits fast growth (Schill 1991) not usually associated with freestone rivers head-watered in the Sawtooth Batholith. Although wild trout survival is relatively short-lived, the mosaic of regulations on the Big Wood River have not resulted in differing age or size structures. Alternatively, identifying if either harvest or natural mortality is potentially limiting Rainbow Trout from obtaining length infinity is necessary before any changes to regulations are proposed. To complete this, angler use and harvest data is needed via tagging wild trout across all reaches in the Big Wood River.

RECOMMENDATIONS

1. Continue triennial trend population monitoring in the fall of 2021.

2. Conduct angler use and harvest estimates for wild and hatchery fish throughout the drainage and try to distribute tags within each established regulation section.

Figure 17. Big Wood River sample sites indicated by the stars; from top to bottom (Boulder, Gimlet, Hailey).

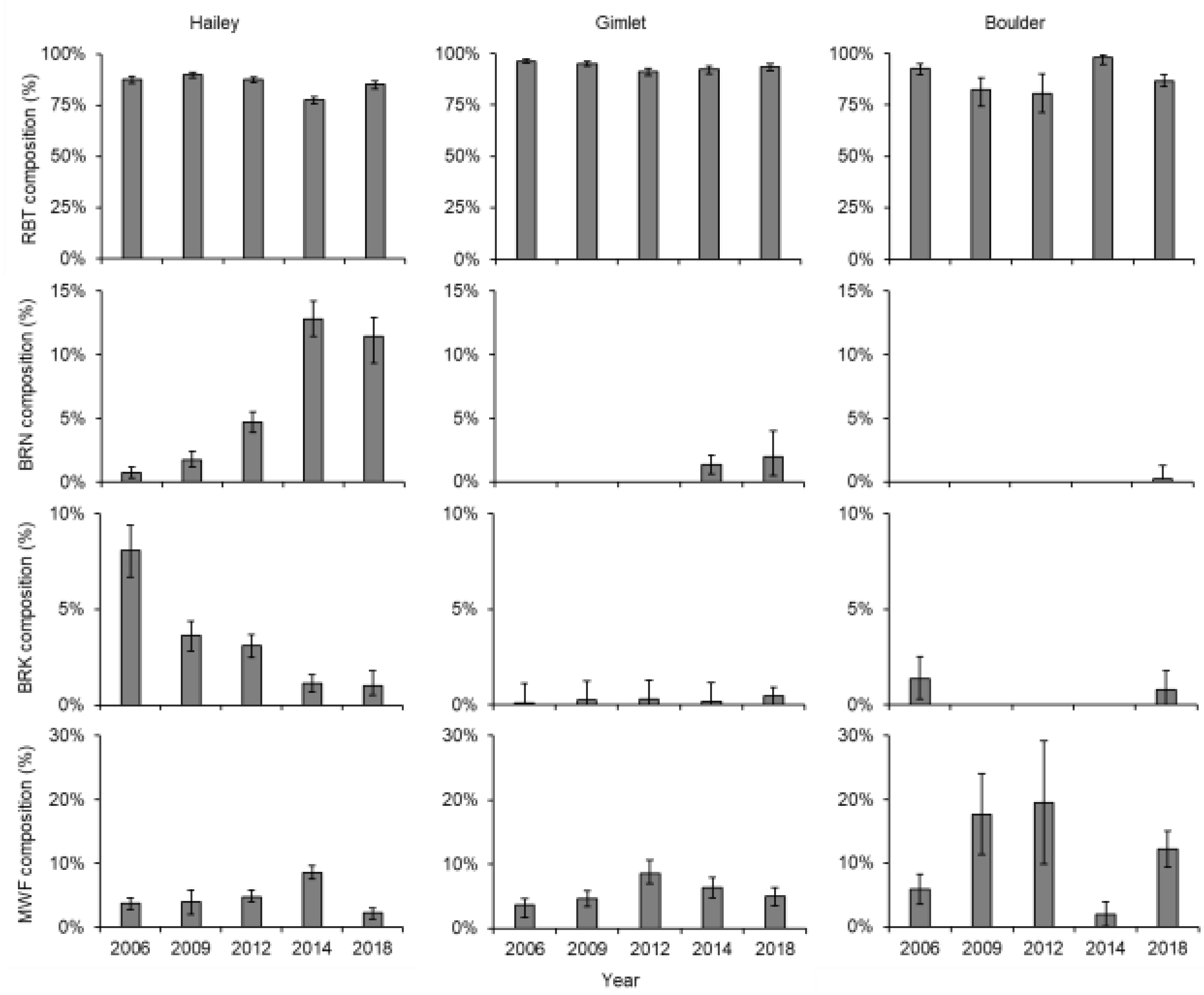

Figure 18. Species composition within study reaches and across years (2006-2018) on the Big Wood River.

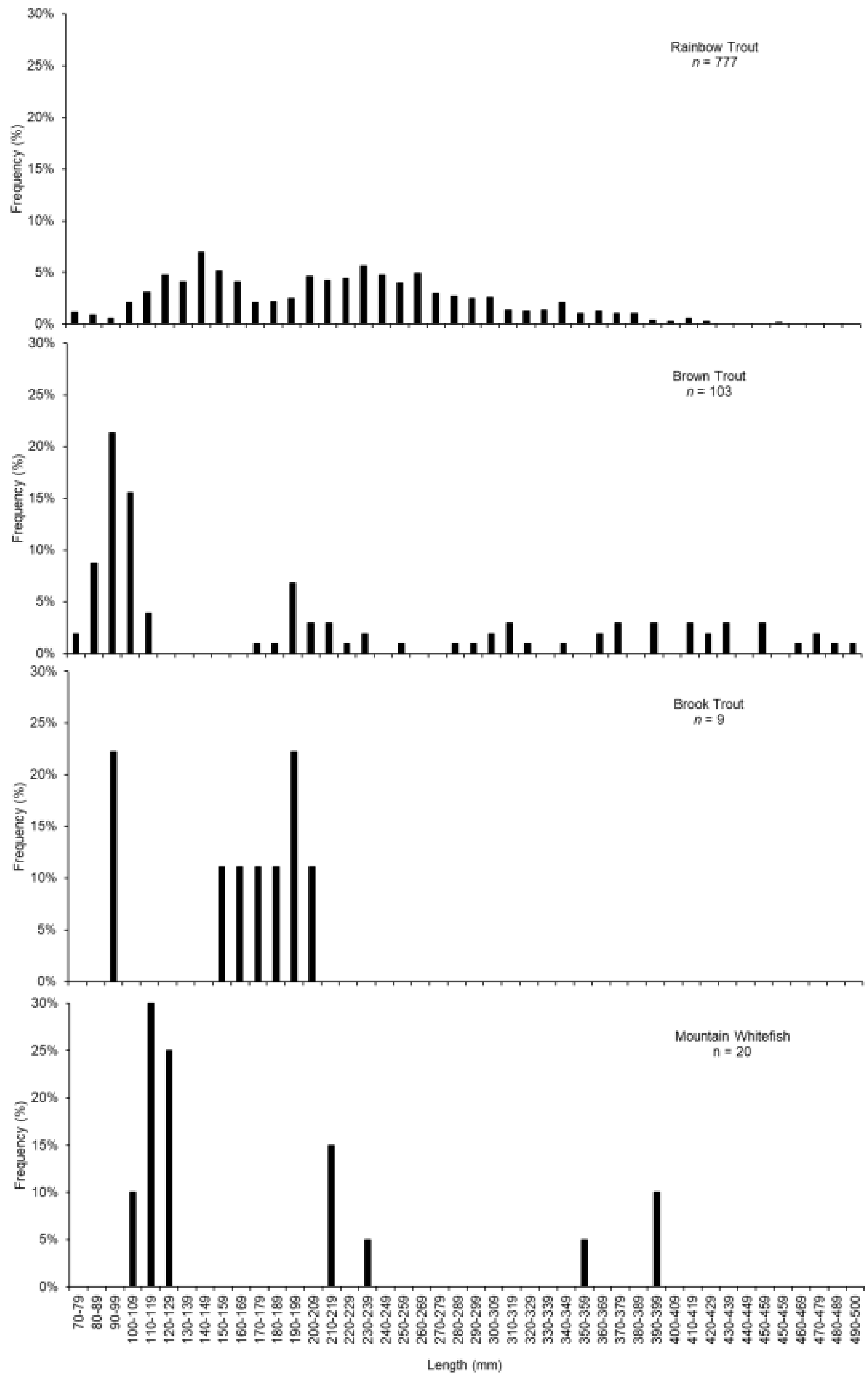

Figure 19. Catch frequency of Rainbow Trout, Brown Trout, Brook Trout, and Mountain Whitefish sampled within the Hailey reach on the Big Wood River, from the fall of 2018.

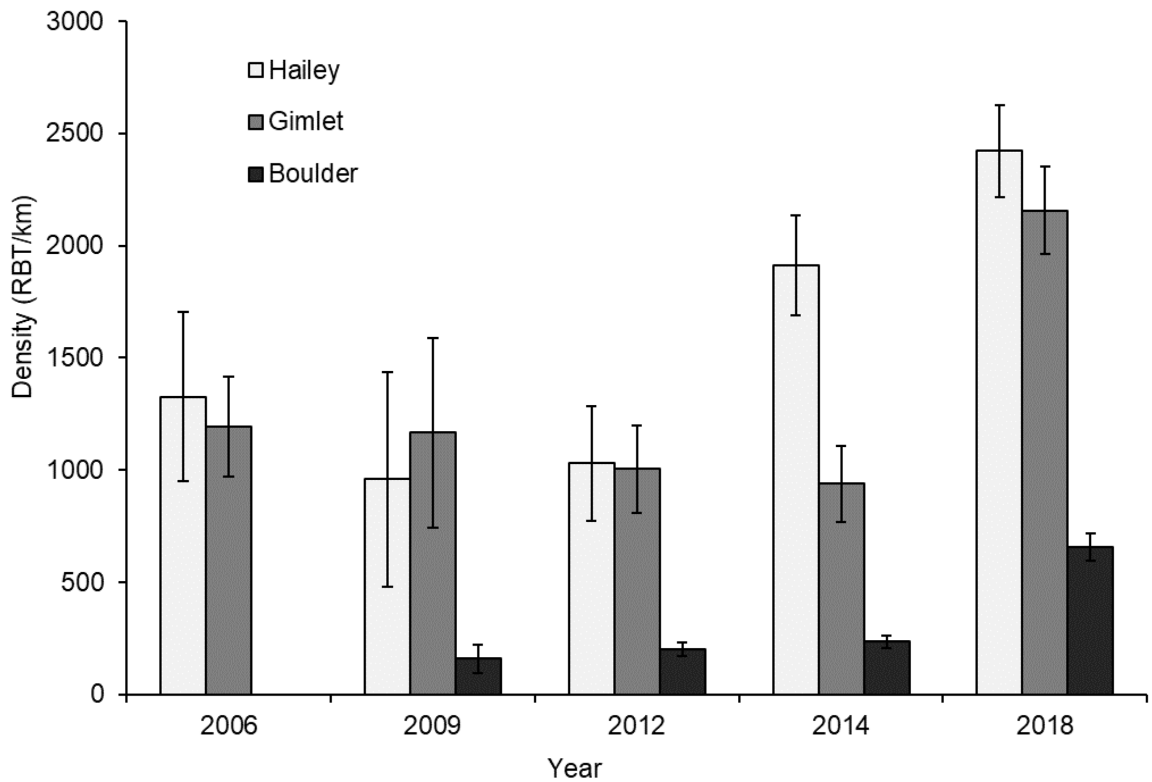

Figure 20. Estimated Rainbow Trout densities from three monitoring transects on the Big Wood River from surveys conducted between 2006 to 2018.

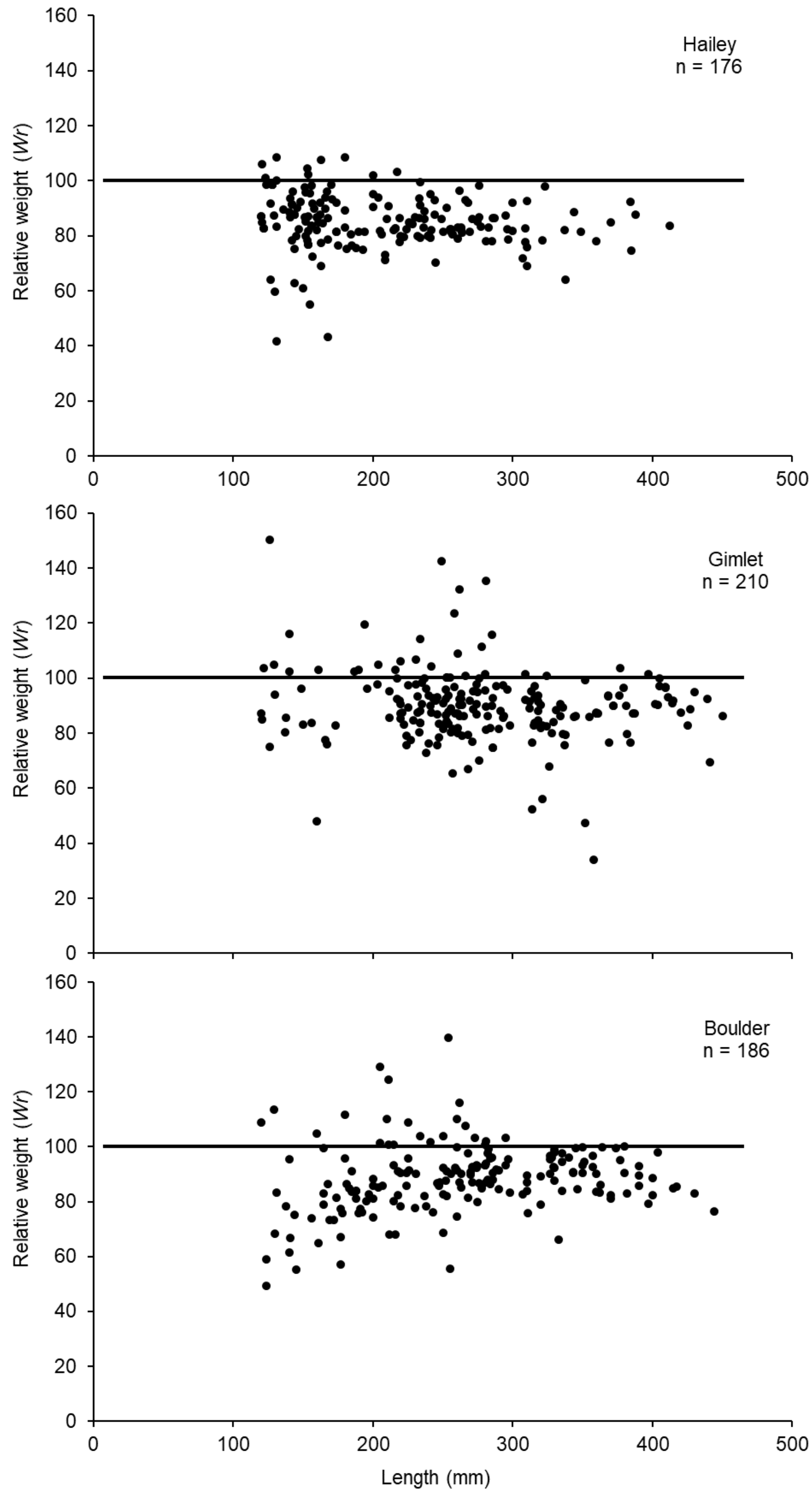

Figure 21. Relative weight of Rainbow Trout (RBT) sampled within the three identified reaches on the Big Wood River, from the fall of 2018.

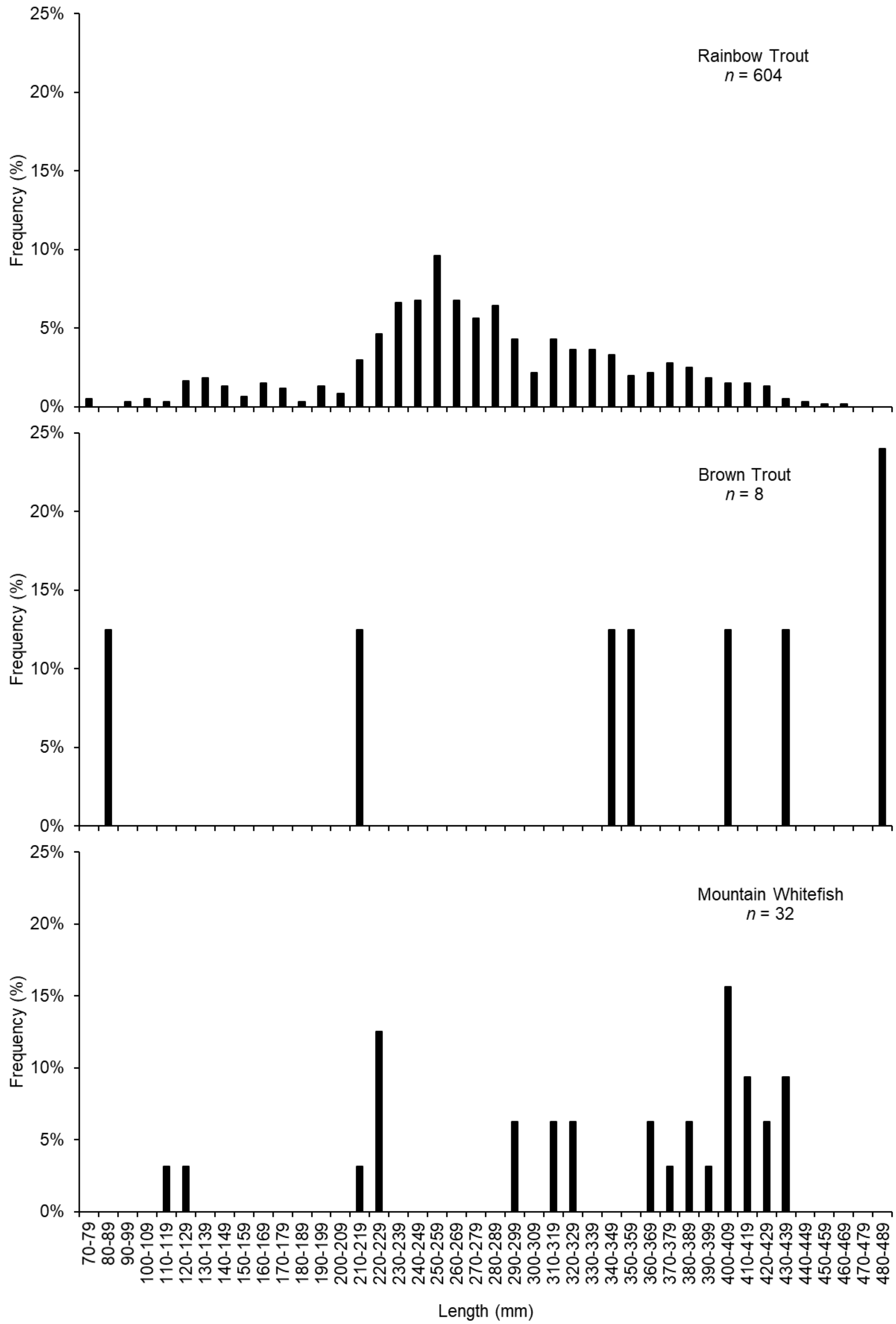

Figure 22. Catch frequency of Rainbow Trout, Brown Trout, and Mountain Whitefish sampled within the Gimlet reach on the Big Wood River, from the fall of 2018.

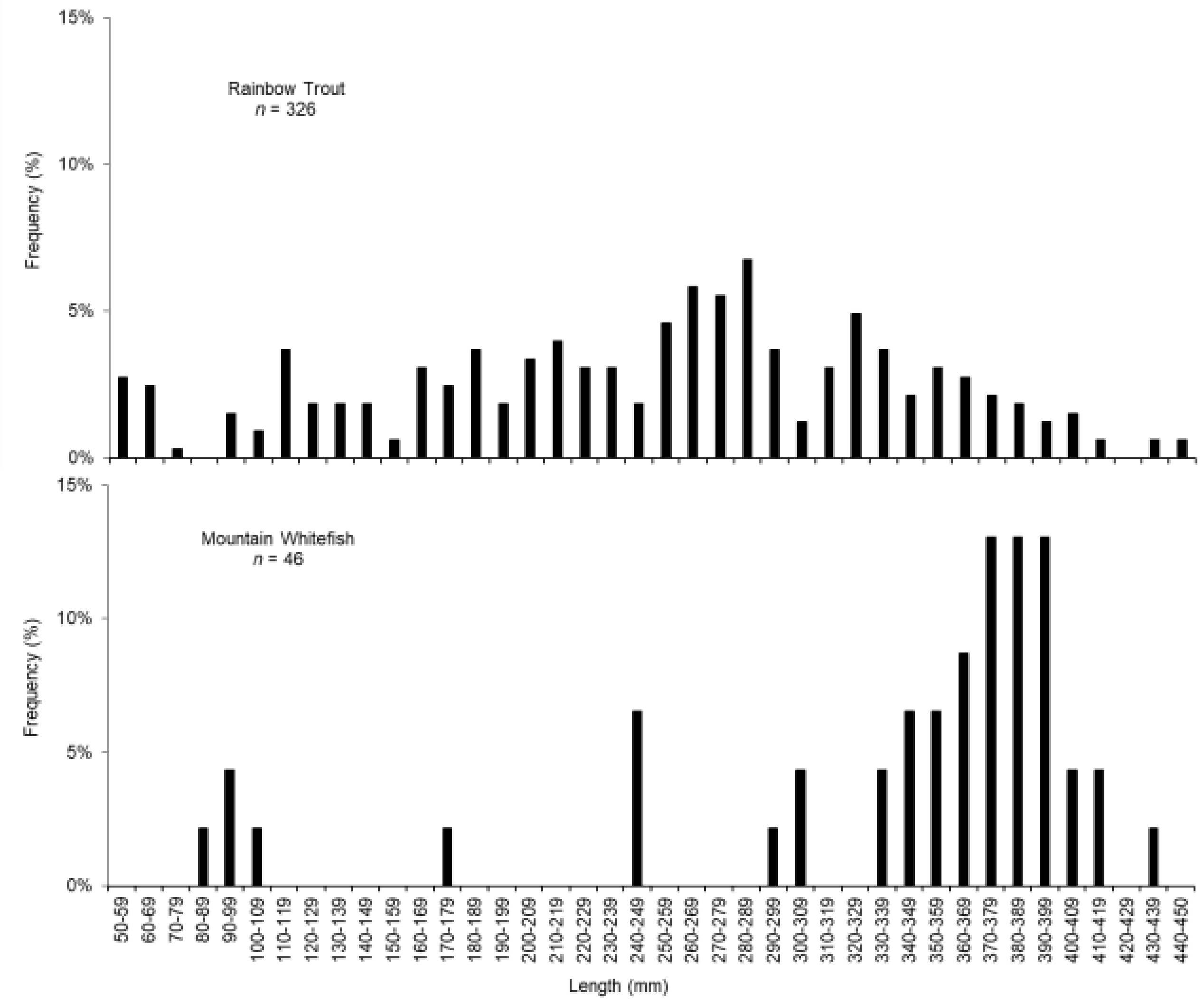

Figure 23. Catch frequency of Rainbow Trout and Mountain Whitefish sampled within the Boulder reach on the Big Wood River, from the fall of 2018.

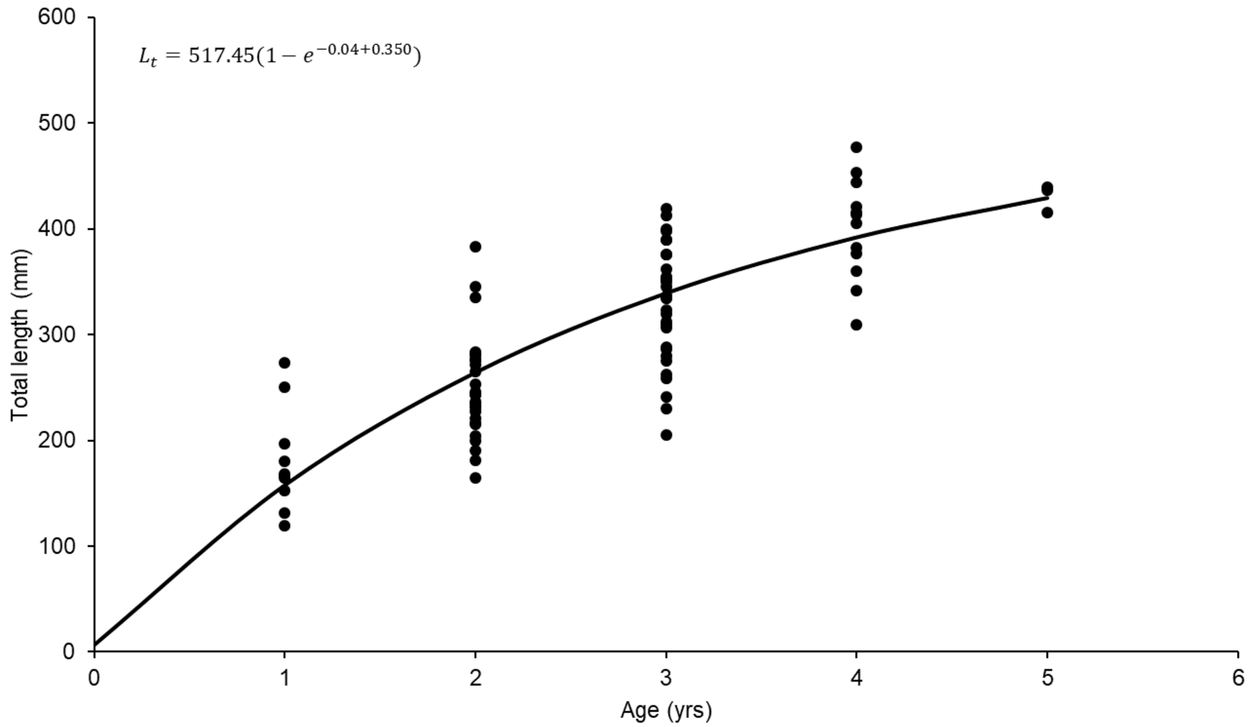

Figure 24. Von Berlanffy growth curve of Rainbow Trout (*n* = 83) from the Big Wood River in 2018.

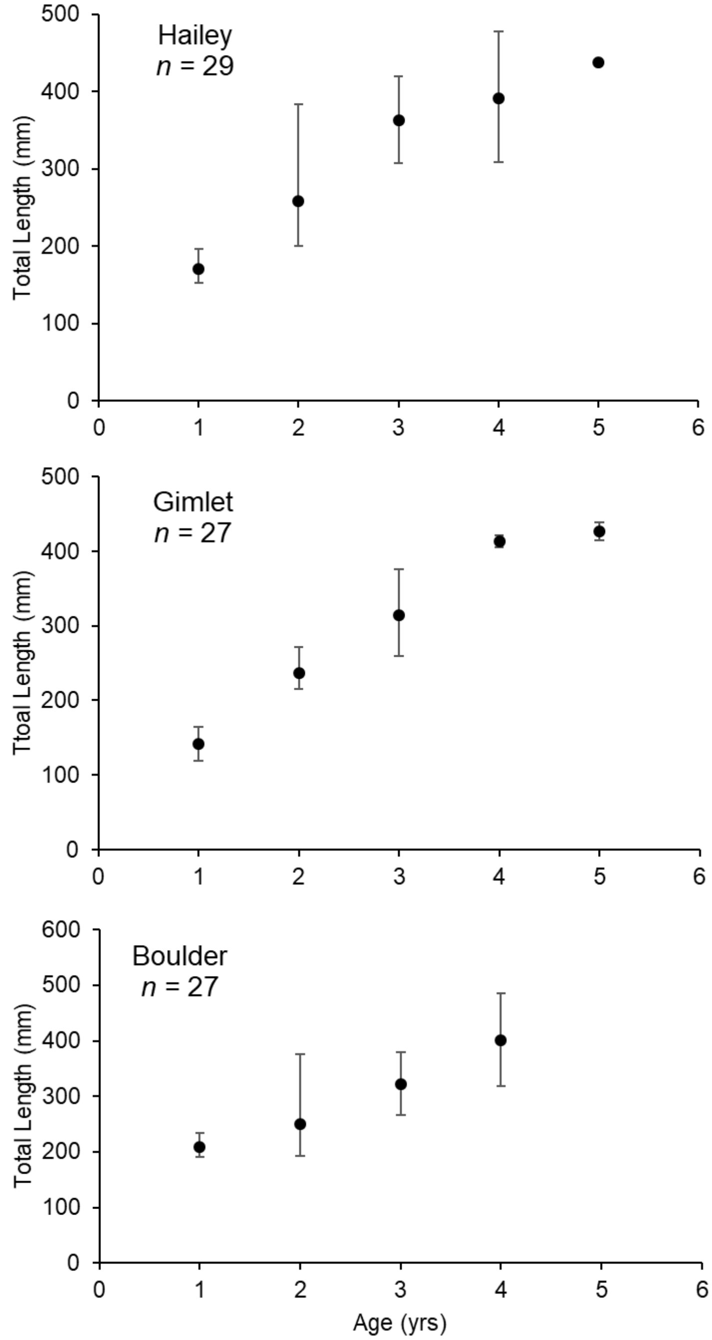

Figure 25. Mean length-at-age of Rainbow Trout per transect from Big Wood River, with min and max total length ranges per age.

BIG COTTONWOOD CREEK YELLOWSTONE CUTTHROAT TROUT MONITORING

ABSTRACT

The Canyon Creek fire in 2012 burned the entirety of Big Cottonwood Creek canyon resulting in the eradication of an isolated population of beaver and a complete loss of riparian vegetation and trees; namely, old growth cottonwoods. Idaho Department of Fish and Game sampled Big Cottonwood Creek via backpack electrofishing to establish baseline relative abundance data for Yellowstone Cutthroat Trout *Oncorhynchus clarkii bouvieri* prior to Beaver reintroduction into the drainage. Metrics including catch-per-unit-effort (CPUE), mean length, and relative weight will be compared to the sampling results three years after beavers are re-introduced. Current data was also compared to past data collected for this population. CPUE (± CI 90%) of Yellowstone Cutthroat Trout at Big Cottonwood Creek was 26 YCT/100 m (± 11). Mean length of Yellowstone Cutthroat Trout was 193 mm (± 4). Mean relative weight for YCT in Big Cottonwood Creek was 98.

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INTRODUCTION

Big Cottonwood Creek hosts a disjunct population of Yellowstone Cutthroat Trout *Oncorhynchus clarkii bouvieri* (YCT), which the Idaho Department of Fish and Game (IDFG) has monitored periodically since 1999. The fishery is managed according to the IDFG YCT management plan and supports a two-fish daily bag limit. Access to Big Cottonwood Drainage is public and is co-managed by IDFG, BLM, and USFS. The entrance to the drainage is located on the Big Cottonwood Creek WMA, which is 13 miles northwest of Oakley, Idaho. The Canyon Creek fire in 2012 burned the entirety of Big Cottonwood Creek Canyon, eradicating a population of beaver and causing a complete loss of riparian vegetation and trees along the creek; namely, old growth cottonwoods. IDFG and the U.S. Sawtooth National Forest Service, Minidoka Ranger District collaborated in restoring native vegetation and riparian habitat throughout the drainage starting in 2014. Remnant beaver ponds persisted until the 2017 spring runoff decimated the remaining ponds. Without the beaver ponds and riparian vegetation to protect the streambed, spring runoff has scoured and channelized the creek, dropping the upper section of creek an estimated 0.5 m in elevation.

The objectives of this study are to collect baseline relative abundance data for YCT prior to the beaver reintroductions into the drainage. Yellowstone Cutthroat Trout population metrics that were measured, included catch-per-unit-effort (CPUE), mean length, and relative weight. These metrics were compared to previous surveys and will be compared to future sampling events conducted post beaver reintroduction.

METHODS

Fish Sampling and Sample Sites

Fish sampling utilized single-pass backpack electrofishing with a Smithroot LR-24 backpack shocker, at optimized outputs for each site (Bertrand et al. 2006). Fish collected were held in a bucket containing a portable aerator and water. All captured fish were identified to species, enumerated, measured (total length) to the nearest mm, and weighed to the nearest g before being released back into the stream. Sampling was conducted in July 2018 following reductions in spring stream flows. Relative abundance was indexed as catch per unit effort (fish/100 m of electrofishing). Relative weight (W_r) for individual fish ≥130 mm were estimated by using the equations presented in Wege and Anderson (1978) as described above for the Big Wood River Population Trend Monitoring.

Three sample sites were selected where beaver ponds were present prior to the 2017 runoff season and remnant beaver dams and ponds were no longer intact. Sample reaches represented all three management agencies: including IDFG, BLM, and USFS.

Beaver Collection and Introduction

A total of five beavers were live trapped within the Magic Valley Region and translocated to Big Cottonwood Creek in August 2018. Beavers were released at the upper most transect, where remnant beaver activity was visible. For trapping and release methods please see Snoddy et al. (*in review).*

RESULTS

The three electrofishing transects totaled 771 m of stream. A total of 200 YCT were encountered with TL ranging from 34 to 326 mm, and a mean TL (± 90% CI) of 193 mm (± 4) mm (Figure 22). CPUE of Yellowstone Cutthroat Trout at Big Cottonwood Creek was 26 YCT/100 m (± 11) of electrofishing. Mean relative weight for YCT in Big Cottonwood Creek was 98 (Figure 23).

DISCUSSION

CPUE of YCT in Big Cottonwood Creek have slightly declined since the 1999 survey and remained similar to the 2015 survey (unpublished data, IDFG; Table 1). Also, mean lengths have significantly increased in that same timespan (Table 1). Notable shifts in relative weight have not been observed comparing pre and post fire data (Table 1). Sediment deposition released from remnant beaver dams, which failed in 2017, may have limited success of adult spawning and juvenile recruitment of YCT in Big Cottonwood Creek; however, young of the year fish were observed in low numbers during the survey. Additionally, increased substrate scouring and channelization in the absence of beaver ponds has likely reduced juvenile YCT rearing habitat. The introduced beavers should help stabilize the riparian habitat and add diversity to juvenile rearing habitat while the stream continues to heal from the 2012 fire. Continued monitoring of this YCT population is important to ensuring the population continues to persist into the future.

RECOMMENDATIONS

1. Revisit the established transects in 2021 to monitor trends in the YCT population.

2. Use multiple-pass depletion estimates to calculate the total population to make more accurate trend comparisons.

Table 1. Total catch, catch-per-unit-effort (CPUE) and mean TL (mm) of Yellowstone Cutthroat Trout sampled by year in Big Cottonwood Creek via backpack electrofishing. Error term indicated 90% confidence intervals.

Year	Catch	CPUE/100 m	Mean TL (mm)	W_r
2018	200	26 ± 11	193 ± 4	98
2015	168	38 ± 17	163 ± 8	93
1999	45	50 ± 2	117 ± 18	102

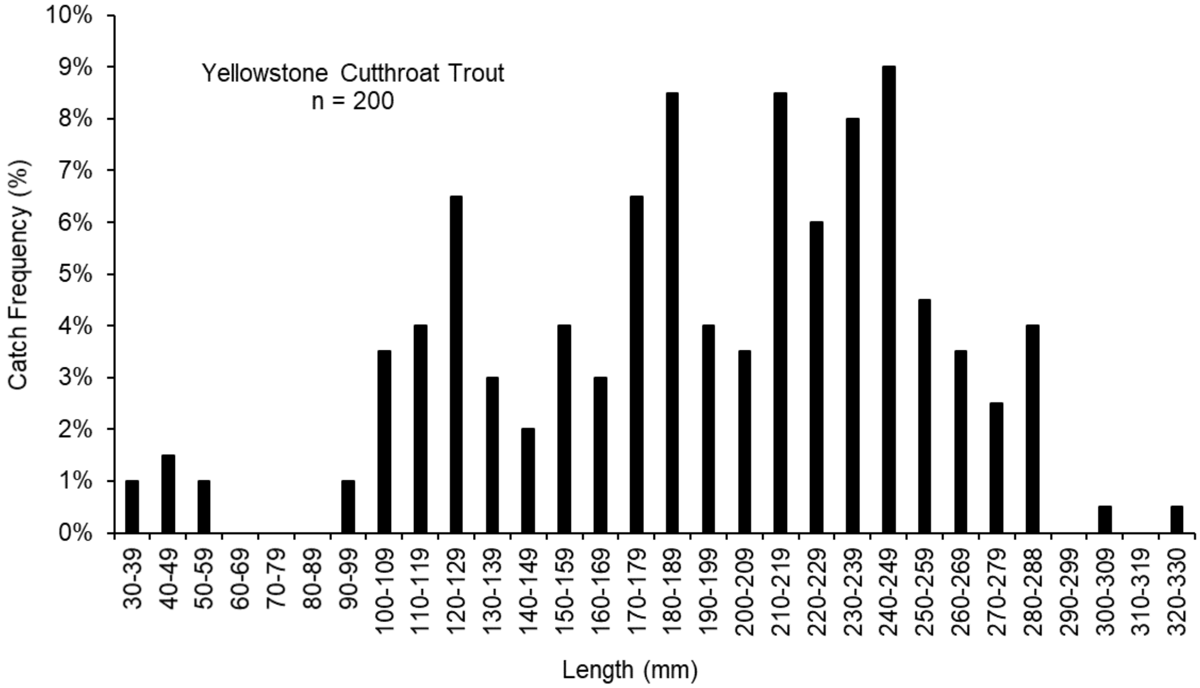

Figure 26. Length frequency of Yellowstone Cutthroat Trout backpack electrofishing catch, in 2018 at Big Cottonwood Creek.

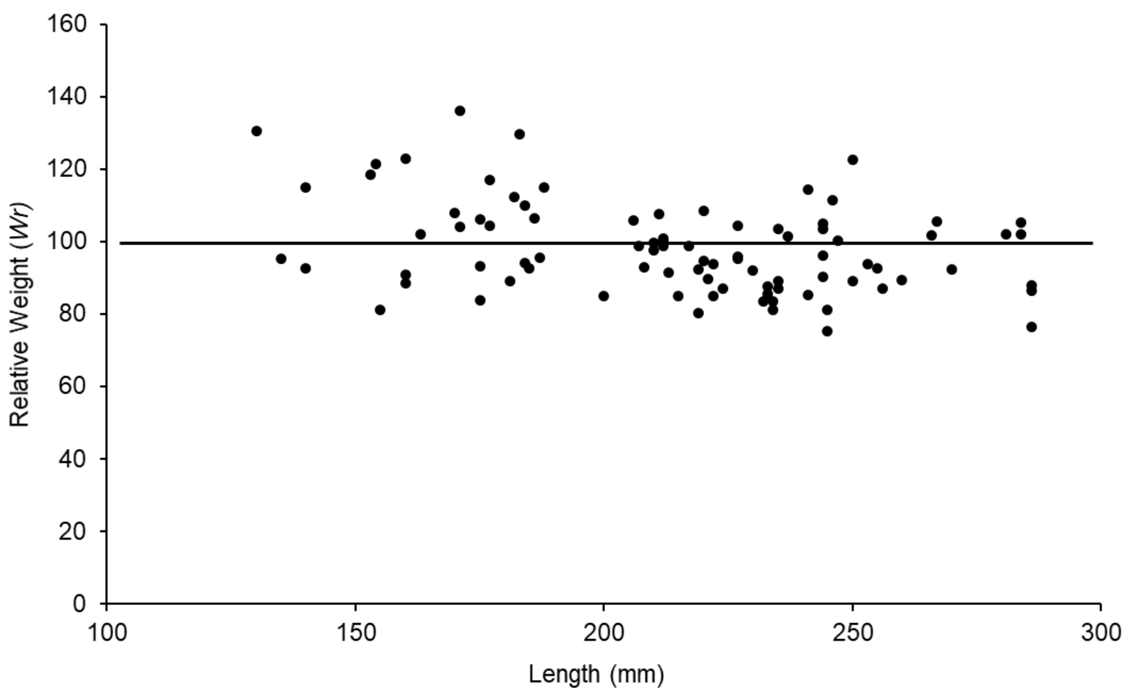

Figure 27. Mean relative weight for YCT in Big Cottonwood Creek.

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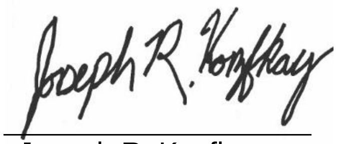

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